IN THE UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

FARE TECHNOLOGIES, LLC, Plaintiff, v. UBER TECHNOLOGIES, INC. d/b/a UBER, Defendant.	)	C.A. No. 6:22-cv-00317-ADA

UBER'S OPENING CLAIM CONSTRUCTION BRIEF

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Pursuant to the Court's Scheduling Order (Dkt. 27) as amended (Dkt. 28), Defendant Uber Technologies, Inc. d/b/a/ Uber ("Uber") serves this Opening Claim Construction Brief on Plaintiff Fare Technologies, LLC ("Fare").[1] As set forth herein, Uber requests that the Court construe five terms from Claims 1, 7, and 12 of the sole patent-in-suit, U.S. Patent No. RE46,727 (the '727 Patent). The '727 Patent expired on August 18, 2018.

I. INTRODUCTION

The '727 Patent, which was filed in 1998, is directed to an improved "taxi trip meter system." With respect to the then existing prior art, the '727 Patent explains that "[a] taxi fare is typically determined by a taximeter based on trip distance and waiting time in traffic" and "[t]axi drivers are free to take whichever route they choose." Ex. 1, '727 Patent, 1:24-26. Taxi drivers, however, can abuse this freedom to take advantage of customers. For example, "[r]iders who are unfamiliar with the area being traversed are sometimes cheated by unscrupulous taxi drivers who take a roundabout route to inflate the fare." *Id*. at 1:26-29. As another example, "taxi drivers [may] try to increase income by driving very fast to minimize travel time and thus increasing customer turnover, but at the expense of safety." *Id*. at 1:29-31.

To address these potential abuses, the '727 Patent proposes solutions that include determining "a distance violation," "a speed violation," or "a fare violation." *Id*. at Abstract. To identify these violations, the '727 Patent proposes a taxi trip meter system that records the trip route between the starting point and destination point of a taxi ride. *Id*. at 2:39-52. When the taxi ride concludes, the taxi trip meter system determines whether a violation occurred. *Id*. at

[1] A week before the due date for this brief, Fare sought leave to amend its preliminary infringement contentions to add claims 30-32 and 37-41. (Dkt. 30.) That motion is untimely, improper and in violation of the Court's OGP. Accordingly, this claim construction brief only addresses terms in the claims originally asserted by Fare.

Figs. 2-3. For example, to determine whether a distance violation occurred, the system determines actual distance, estimates the shortest distance, determines a permissible margin over the shortest distance, then compares the actual distance to the permissible margin. *Id*. at 2:52-3:8, Fig. 2. Similarly, a fare violation is raised when the actual fare exceeds an estimated taxi fare by a permissible margin. (*Id*. at Abstract.)

The '727 Patent is directed to a problem that is not faced by Uber and, thus, the '727 Patent is inapplicable to Uber. Rideshares are not taxis. Rideshare vehicles do not have a taximeter and are not hired on demand (*i.e*., by hailing them on the street). Instead, ridesharing operates on a contract basis, more akin to how limousines operated in 1998. A rider contracts with either Uber or a limo company to be picked up and dropped off at predetermined locations for an agreed-upon price. In fact, Uber's business started as a way for passengers to book limos and other black cars for transportation. (Ex. 2.) The expansion of Uber's business where riders can now book any type of vehicle, not just black cars, does not change that underlying business model.

Because the '727 Patent is directed to taxi technology, not rideshares or even limousines, Fare's infringement claims rely on distorted meanings for terms in the '727 Patent. For example, the terms "taxi," "trip meter," and "waiting time" all had very specific meanings in the taxi industry in 1998 and are inapplicable to modern rideshare. And while the terms "starting point" and "destination point" could be applicable to modern rideshare, their meanings are clear from their use in the asserted claims and are consistent with their plain and ordinary meaning in the taxi industry. Accordingly, Uber requests that the Court construe the five proposed terms consistent with their plain and ordinary meanings in the taxi industry in 1998, which are consistent with their use in the '727 Patent. These constructions are claim dispositive.

II. LEGAL PRINCIPLES OF PATENT CLAIM CONSTRUCTION

When the parties dispute the scope of a claim term, "the court, not the jury, must resolve that dispute." *O2 Micro Int'l Ltd. v. Beyond Innovation Tech. Co.*, 521 F.3d 1351, 1360 (Fed. Cir. 2008). The ultimate conclusion in claim construction is a question of law. *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 574 U.S. 318, 325 (2015). However, "subsidiary factfinding is sometimes necessary," such as when the court must understand the science behind technical terms. *Id.* at 326.

"Claim terms generally are construed in accordance with" their "ordinary and customary meaning." *Samsung Elecs. Co. v. Elm 3DS Innovations, LLC*, 925 F.3d 1373, 1377 (Fed. Cir. 2019) (quotation marks omitted). "[T]he ordinary and customary meaning of a claim term is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention, i.e., as of the effective filing date of the patent application." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005). Courts will "deviate from a claim term's ordinary meaning," however, "when a patentee sets out a definition and acts as its own lexicographer or when the patentee disavows the full scope of a claim term either in the specification or during prosecution." *Samsung, 925 F.3d* at 1377-78 (quotation marks omitted). "A determination that a claim term 'needs no construction' or has the 'plain and ordinary meaning' may be inadequate when a term has more than one 'ordinary' meaning or when reliance on a term's 'ordinary' meaning does not resolve the parties' dispute." *O2 Micro*, 521 F.3d at 1361.

In claim construction, the Court must look first to "intrinsic" evidence: the claim language, specification, and prosecution history. *Phillips* 415 F.3d at 1314-15. The specification "is the single best guide to the meaning of a disputed term." *Id.* at 1315. Courts may rely on extrinsic evidence, such as "expert and inventor testimony, dictionaries, and learned treatises."

Id. at 1317. A patent may be "so interspersed with technical terms and terms of art that the testimony of scientific witnesses is indispensable to a correct understanding of its meaning." *Seymour v. Osborne*, 78 U.S. 516 (1871) (cited with approval in *Teva Pharms.*, 574 U.S. at 331-32). An expert "may explain terms of art and the state of the art at any given time." *Teva Pharms. USA, Inc. v. Sandoz, Inc.*, 789 F.3d 1335, 1339 (Fed. Cir. 2015). "[T]he testimony of one skilled in the art about the meaning of claims terms at the time of invention will almost always qualify as relevant evidence." *Eastman Kodak Co. v. Goodyear Tire & Rubber Co.*, 114 F.3d 1547, 1555 (Fed. Cir. 1999) (abrogated on other grounds in *Cybor Corp. v. FAS Techs., Inc.*, 138 F.3d 1448 (Fed.Cir.1998) (en banc)).

A patent claim is indefinite if it fails to provide reasonable certainty regarding the scope of the claimed invention to a person of skill in the art. *Nautilus, Inc. v. Biosig Instruments, Inc.*, 572 U.S. 898, 901 (2014). "The claims, when read in light of the specification and the prosecution history, must provide objective boundaries for those of skill in the art." *Interval Licensing LLC v. AOL, Inc.*, 766 F.3d 1364, 1371 (Fed. Cir. 2014). If a claim does not satisfy the above requirements, then it is invalid under § 112. *Nautilus*, 572 U.S. at 901. "The indefiniteness inquiry ... is intertwined with claim construction ... ." *Eidos Display, LLC v. AU Optronics Corp.*, 779 F.3d 1360, 1364 (Fed. Cir. 2015).

III. ARGUMENT

A. "Taxi"

Claim(s)	Plaintiff's Proposed Construction	Defendant's Proposed Construction
Claim 1	Plain and ordinary meaning.	"an automobile licensed for hire as a taxi or taxicab and fitted with a meter"

Claim 1 of the '727 Patent is directed towards "[a] taxi trip meter system for a ***taxi***." This claim also requires "measuring an actual trip distance traveled by said ***taxi*** between a starting point and a destination point" and "providing geographical location information about said ***taxi*** to said computer." The '727 Patent does not define a taxi other than to say it is a vehicle. (Ex. 1, '727 Patent, 2:21-26.)

A taxi, however, cannot just be any vehicle that transports people in exchange for some compensation. Such a broad construction, as is inherent in Fare's infringement allegations, would sweep in limos, buses, and even carpools where gas money is paid. As explained, the problems identified by the '727 Patent, namely taking an inefficient route to increase a fare, are only applicable to taxis, and not limos or other vehicles. Thus, consistent with a POSITA's understanding, a taxi is defined by at least two requirements: (1) it is licensed for hire, and (2) it is fitted with a meter. (Ex. 3, Mundy Decl. at ¶ 27-33.)

First, a taxi is an automobile that is licensed for hire as a taxi or taxicab. (*Id*.) A "taxicab is the oldest form of licensed public transportation in the world, with the first licensing of taxis traceable to the Seventeenth century." (Ex. 4, Taxi!, at 7.) The term "taxi" comes from the German word for "tax." (Ex. 3, Mundy Decl. at ¶ 27.) A taxi is also referred to as a taxicab, which "is a contraction of the German word Taxe, meaning tax or charge, and the French term Cabriolet, originally the name for a style of horse carriage that would also be applied to automobiles." (Ex. 5, Is the Fare Fair, at 2.)

"Regulations, the legislation impacting on the supply of taxis, have emerged as a result of the history of the taxicab and are commonly applied to the numbers of vehicles licensed (quantity control), to vehicle and operator fitness standards (quality control) and to their fares (economic control), collectively as QQE." (Ex. 4, Taxi!, at 35; *see also* Ex. 3, Mundy Decl. at ¶

28.) In the United States, "cities and local authority areas defined as licensing authorities" regulate taxis to "protect[] the public interest." (Ex. 4, Taxi!, at 35)

Licensing authorities define what constitutes a taxi or taxicab. (Ex. 3, Mundy Decl. at ¶ 28.) The regulations for licensing taxis and taxicabs vary by regions. (*Id*. at ¶ 32.) In the United States, taxis are typically defined in a similar manner as Hillsborough County's regulatory definition: "any motor-driven vehicle, equipped with a taximeter with a capacity for 6 or less passengers, including the driver." (*Id*.)

Second, a taxi is an automobile that is fitted with a meter. (*Id*. at ¶ 27-33.) For example, in 1992, the city of Austin, Texas described taxicab service as "service that operates on irregular routes and schedules on a call-and-demand basis, for compensation for that is usually determined by a meter." (Ex. 6, Austin Code Subpart N; *see also* Ex. 4, Taxi!, at 54 (Hillsborough County's regulatory definition).) This description aligns with the 1997 Oxford Dictionary definition of "automobile licensed for hire and usu. fitted with a meter." (Ex. 7, Oxford Dictionary at 821 (abbreviating "usually" as "usu.").) In fact, the Patent Office has previously adopted this definition as the plain and ordinary meaning of "taxi." (Ex. 8, IPR2017-01865, Paper 21 at 8.)

The use of the word "usually" in these definitions is to contrast taxi service from carriers, such as limousines, that provide rides for a prearranged fee. (Ex. 3, Mundy Decl. at ¶¶ 29-30.) For example, "non-metered sedans known as Black Car services" are found in New York City. (Ex. 4, Taxi!, at 63.) Accordingly, a POSITA in 1998 would understand that a taxi was fitted with a meter in order to determine the fare of a ride – the same meter that is allegedly abused by drivers and is at the heart of the '727 Patent.

* * * *

Fare does not provide a construction for the term "taxi," stating that it should be given its plain and ordinary meaning. Adopting such a construction would constitute legal error as a jury may not understand "taxi" consistently with the understanding of a POSITA in 1998. *Eon Corp. IP Holdings LLC v. Silver Spring Networks, Inc.*, 815 F.3d 1314, 1319 (Fed. Cir. 2016) (the district court erred by finding that claim terms are entitled to their "plain and ordinary meaning" and not resolving the parties' dispute over the scope of a claim term); *NobelBiz, Inc. v. Global Connect, L.L.C.*, 701 Fed. App'x. 995, 998 (Fed. Cir. 2017) (district erred by failing to construe the claim beyond its "plain and ordinary meaning.").

Thus, for all the reasons described above, the Court should adopt the plain and ordinary meaning of the term taxi to a POSITA: "an automobile licensed for hire as a taxi or taxicab and fitted with a meter."

B. "Trip Meter"

Claim(s)	Plaintiff's Proposed Construction	Defendant's Proposed Construction
Claim 1	Plain and ordinary meaning.	"a device in the taxi that determines distance traveled using input collected from the taxi"

Claim 1 of the '727 Patent recites the limitation "a ***trip meter*** connected to said computer, said ***trip meter*** for measuring an actual trip distance traveled by said taxi between a starting point and a destination point." This is another claim term where the plain and ordinary meaning to a POSITA was well known, but without an express construction, could be confusing to the jury.

A POSITA in 1998 understood that a taxi trip meter determines the distance traveled using input from the taxi itself. (Ex. 3, Mundy Decl. at ¶ 39.) Initially, the meter measured distance traveled by attaching a cable to the non-driving wheel and counting the revolutions. (Ex. 5, Is the Fare Fair, at 3.) Thereafter, the "meter [was] attached to the taxi's transmission

instead of the wheel." (*Id*.) "To get the distance traveled, the meter relies on a sensor attached to the cab's transmission. The sensor sends an electric pulse to the meter every time the cab travels a given distance." (Ex. 9, How Taxi Meters Work, at 3; *see also*, Ex. 10, Oka, 1:12-16; Ex. 11, Ricard, 6:55-61.) Other meter designs received inputs from the taxi's odometer. (Ex. 12, Murphy, 4:45-48; Ex. 10, Oka, 2:62-68.)

This understanding is consistent with the plain claim language and the specification of the '727 Patent. Claim 1 specifies that the "trip meter" measures distance traveled. And, the '727 Patent explains that a "trip meter" measures distance without the use of GPS and map data. In fact, the '727 Patent states that a "trip meter may be eliminated" when "the trip distance [is] determined with GPS and map data." (Ex. 1, '727 Patent, 4:37-39.) Accordingly, the "trip meter" described in the '727 Patent must determine distance by using information received from the taxi rather than from GPS or map data, consistent with Uber's proposed construction and the understanding of a POSITA. (Ex. 3, Mundy Decl. at ¶¶ 39-46.)

* * * *

Fare does not provide a construction for the term "trip meter" stating that it should be given its plain and ordinary meaning without explaining a POSITA's understanding of that term. Without a construction, however, Fare is likely to argue, as it does in its infringement contentions, that Uber's App, which relies on GPS, qualifies as a "trip meter." Accordingly, the Court should provide an express construction of this term to be consistent with the plain and ordinary meaning of the term to a POSITA in 1998. *AFG Indus., Inc. v. Cardinal IG Co.,* 239 F.3d 1239, 1247 (Fed. Cir. 2001) ("It is critical for trial courts to set forth an express construction of the material claim terms in dispute.")

C. "Starting Point" and "Destination Point"

Term	Claim(s)	Plaintiff's Proposed Construction	Defendant's Proposed Construction
Starting Point	Claims 1, 7, 12	Plain and ordinary meaning.	"geographical location where the ride began"
Destination Point	Claims 1, 7, 12	Plain and ordinary meaning.	"geographical location where the ride ended"

Uber requests that the Court define the terms "starting point" and "destination point" because those terms have a specific meaning within the context of the asserted claims, which is consistent with their plain and ordinary meaning to a POSITA. If the plain language is presented to the jury, with no construction, the terms could be misunderstood and misapplied by a jury. In such circumstances, the Court should construe the terms instead of relying on their plain and ordinary meaning. *See Abbott Labs. v. Sandoz, Inc.*, 544 F.3d 1341, 1360 (Fed. Cir. 2008) ("claims are construed as an aid to the decision-maker" (citing *Multiform Desiccants, Inc. v. Medzam, Ltd.* 133 F.3d 1473, 1477 (Fed. Cir. 1998))); *United Servs. Auto. Ass'n v. MiTek Sys., Inc.*, No. SA-12-CA-282, slip op., at 5 (W.D. Tex. April 2, 2014) (ordering construction of terms because "the [Magistrate's] Markman opinion offers no basis to support a finding that they would be readily understood by an average fact finder.") Here, there is a significant risk that a jury may ascribe a meaning to these terms that is unsupported by the asserted claims of the '727 Patent.

1. Without Construction, Jury Confusion Is Likely

As used in Claims 1, 7 and 12 of the '727 Patent, the "starting point" and "destination point" refer to the geographic location where a ride begins and ends – in other words, where the taximeter starts and stops tracking the ride to determine the fare. These terms do not mean, as a jury could misunderstand, the location where a rider requests to be picked up or dropped off.

While the location where a taximeter starts and stops could be the same as a rider's requested pick up and drop off location, they are different in application.

For example, in 1998, a rider could arrange for a limo to pick them up at the airport and drive them to their office for a flat fee. When that ride occurs, however, the rider could be picked up at departures, arrivals, the airport garage or someplace else at the airport. And, the rider could be dropped off at their office, or even a few blocks away because traffic is so bad or they decided to grab a sandwich before heading to the office. Regardless of where the pickup and drop-off occurred, the limo would charge the same rate. A taxi, however, charges based on distance and time traveled, so each of those pick-up/drop-off permutations have a different cost. Thus, for the purpose of this '727 Patent, which is a system for estimating the cost of a taxi ride, it is important to know the geographic location of where taxi ride began and ended, and *not* a rider's requested locations.

2. The Plain Language of Claims 1, 7 and 12 Support Uber's Constructions

The plain language of Claims 1, 7 and 12 require that the "starting point" and "destination point" mean the geographic location. Claim 1 recites: "a trip meter connected to said computer, said trip meter for measuring an ***actual*** trip distance traveled by said taxi between a starting point and a destination point." (emphasis added.) Likewise, Claim 7 recites: "determining an ***actual*** trip distance traveled by a vehicle after said trip is completed." (emphasis added.) The only way to measure actual distance is based on the geographic location of the vehicle; any other measure would be an estimate.

Claim 12 is even clearer that the starting point and destination points are the geographic locations where a ride began and ended. While Claim 12 is directed to "[a]n automated taxi fare estimating method" and refers to various estimations elsewhere in the claim, but the starting

point and destination point themselves are not estimates. The starting point is determined "based on the received geographical location information" from "at least one location sensor." (emphasis added.) According to the specification, the location sensor "may be any type of device that indicates the precise geographical location of the vehicle." (Ex. 1, '727 at 2:30-32.) As discussed below, the embodiments disclosed in the specification also confirm this understanding of Claim 12.

3. The Specification Supports Uber's Construction

Uber's proposed construction that the starting point and destination point are the geographic location where the ride began and ended is further supported by the embodiments in the specification, as represented in Figs. 2 and 3:

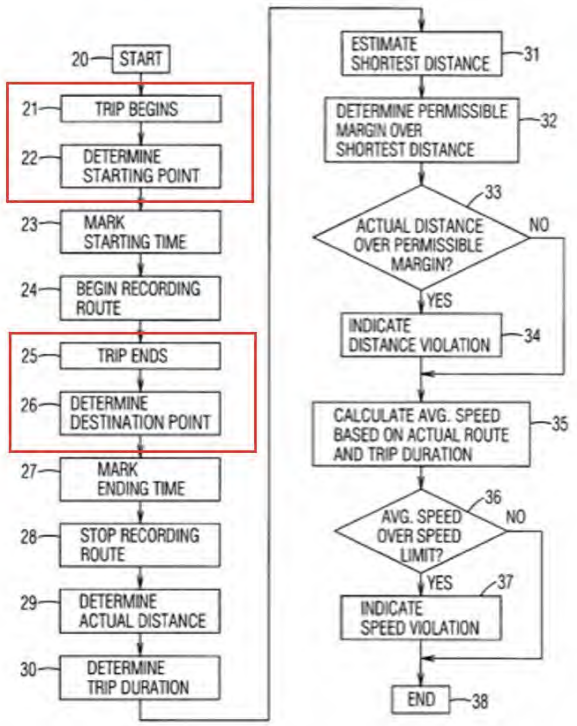


Fig. 2

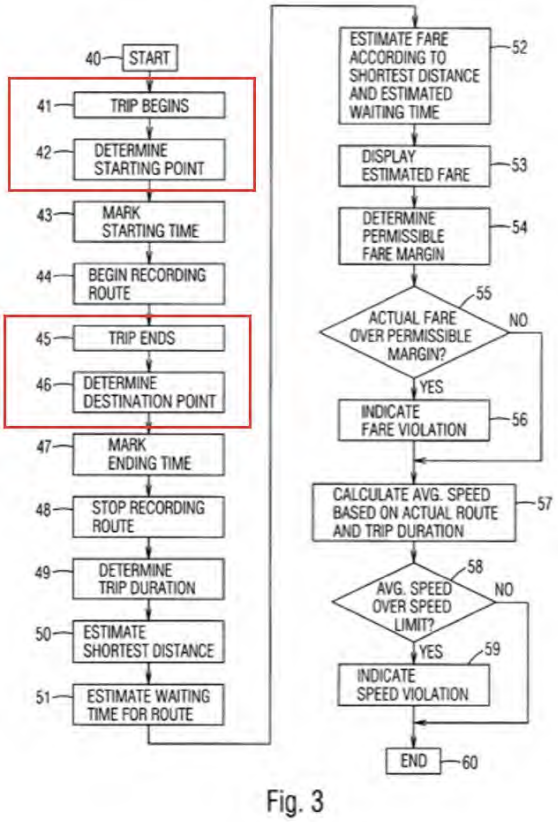


Fig. 3

As shown in the red boxes, in the embodiments represented by these figures, a trip begins and then the starting point is determined, and a trip ends and then the destination point is determined. This is explained in the specification, for example: "[w]hen a trip is begun at block 21, e.g., when the taximeter is activated or a specific initiating input is provided to the computer, the geographical starting point is determined at block 22, and the starting time is marked at block 23." (*Id*. at 2:39-43.)

Confirming adherence to these embodiments, Claim 12 recites "determining" the starting and destination points, which is consistent with the embodiments shown in Figs. 2 and 3 above where boxes 22, 26, 42, and 46 state "Determine [Starting/Destination] Point." By comparison, when the starting and destination points are not based on geographic information, the specification uses "inputted" to describe those points: "the starting and ending points may be inputted before the trip to provide advance notice of the fare." (*Id*. at 4:33-35.) *Impulse Tech. Ltd. v. Microsoft Corp.*, 665 F. App'x. 872, 878 (Fed. Cir. 2016) (where the specification uses different terms to represent different concepts, those terms should be construed to be limited to respective concepts.)

In sum, the embodiments claimed in the asserted claims include determining the starting point and destination point based on when the taximeter starts and stops, not based on any predetermined input, which is consistent with Uber's proposed constructions.

4. Dr. Mundy's Declaration Supports Uber's Construction

Finally, Dr. Mundy concurs with Uber's proposed constructions. (Ex. 3, Mundy Decl. at ¶¶ 47-62.) In his experience, the starting point and destination point of a taxi ride is when a taxi starts and stops the taximeter, which corresponds to the geographic location where the ride begins and where it ends. (*Id*. at ¶¶ 53-54, 61-62.) Thus, for all these reasons, Uber's proposed construction is correct.

D. "Waiting Time Encountered in Traffic"

Claim(s)	Plaintiff's Proposed Construction	Defendant's Proposed Construction
Claim 12	Plain and ordinary meaning.	Indefinite. Alternatively, if the Court determines that the term can be construed: "amount of time spent stopped or below a predefined speed threshold"

Uber requests that the Court find the term "waiting time encountered in traffic" indefinite under 35 U.S.C. § 112 because it is susceptible to multiple reasonable constructions. In the alternative, Uber asserts that this term should be construed consistent with the plain and ordinary meaning of "waiting time" to a POSITA – namely, "amount of time spent stopped or below a predefined threshold."

1. This Term Is Indefinite

Where terms are susceptible to multiple reasonable understandings, they are indefinite under 35 U.S.C. § 112. *See Interval Licensing*, 766 F.3d at 1371 (a term is indefinite "if the claim language might mean several different things and no informed and confident choice is available among the contending definitions") (internal quotations omitted) (citing *Nautilus, Inc. v. Biosig Instruments, Inc.*, 134 S. Ct. 2120, 2130 (2014)); *see also Light Transformation Techs. LLC v. Lighting Sci. Grp. Corp.*, No. 2:12-cv-826-MHS-RSP, 2014 WL 3402125, at *8-9 (E.D. Tex. July 11, 2014) (finding the claims indefinite because a term was subject to multiple plausible constructions).

Here, the term "waiting time encountered in traffic" is indefinite because it has many potential meanings, including the following three examples:

- The difference between an optimal trip time and the current trip time ("Meaning 1"). For example, if a trip typically takes 15 minutes but takes 25 minutes during rush hour, then the waiting time encountered in traffic would be 10 minutes.
- The amount of time when a taxi is "in traffic" ("Meaning 2"). This time reflects the portion of a trip attributable to "traffic lights, traffic congestion, etc." (Ex. 1, '727 Patent at 3:54.) Meaning 2, however, leaves open the question what time qualifies as spent "in traffic."
- Uber's alternative construction, which is consistent with the meaning of "wait time" in the taxi industry in 1998: "amount of time spent stopped or below a predefined speed threshold" (Meaning 3). As explained in Part D.2, below, Uber's alternative construction is consistent with the practice of most taxis to charge a fare based on (1) the distance traveled and/or (2) a "wait time" when the vehicle was below a speed threshold.

In addition to these three meanings, Fare asserts a fourth potential interpretation of "waiting time encountered in traffic," which is the undefined "plain and ordinary meaning." That construction, however, fails to resolve (1) what subset of time within a trip time qualifies as "waiting time encountered in traffic" and (2) what qualifies as "traffic." For example, does time spent in "usual" or even "light" traffic qualify as "waiting time encountered in traffic," or does the traffic have to be "heavy" to qualify, and what are the thresholds for those measurements?[2]

[2] For this reason, the Court can also conclude that this term is indefinite because it includes a term of degree—"traffic"—without providing any standard for measuring what constitutes traffic. *In Interval Licensing*, the Federal Circuit explained that a term of degree is not indefinite only if the claim language and specification provide "some standard for measuring the scope of the phrase." 766 F.3d at 1370–71. Where the intrinsic record fails to do that, the term of degree is indefinite. *Id.* The same is true here. The '727 Patent does not provide any

The differences in the potential meanings for this term have a material impact on the claim scope and require resolution under *O2 Micro*., 521 F.3d at 1361. Meaning 1 would capture the full-time difference between the optimal trip and an actual trip, while Meaning 2 would capture some subset thereof that is tied to "traffic" (however that is defined) and could also require detection of traffic impediments. And, Meaning 3 is limited to the time spent below a predefined speed threshold and would not capture, for example, time spent on a highway in traffic traveling above the threshold, but still well below the speed limit.

The plain language of the claim does not distinguish between these meanings. Claim 12 recites "determining an estimated ***waiting time encountered in traffic*** during said trip based on the geographical location information and the street information." (emphasis added.) The street and geographic information can be used to: determine the optimal travel time and any deviation therefrom (Meaning 1); identify stoplights or other traffic impediments (Meaning 2); and estimate the amount of time that the vehicle spent below a speed threshold (Meaning 3).

The specification of the '727 Patent also does not distinguish between these potential meanings. For example, the '727 Patent provides: "[a]n estimated waiting time in traffic along the optimal route is determined at block 51 based on location traffic information and the time of day to account for traffic lights, traffic congestion, etc. An estimated fare is determined at block 52 based on the estimated shortest trip distance and estimated waiting time, and displayed at block 53." (Ex. 1, '727 Patent, 3:51-57.) This disclosure is consistent with all three potential meanings as it references time of day and traffic along optimal route (Meaning 1); traffic lights and traffic congestion (Meaning 2); and calculating an estimated fare based on the waiting time

standard or guidance for measuring how many road impediments are required to constitute "traffic" under Claim 12.

(Meaning 3). The remaining references to wait time in the specification are all directed to using wait time to calculate the taxi fare and do not impact this construction. (*Id*. at Fig. 3, blocks 51, 52; 1:24-25; 1:46-48; 4:24-26.)

The term "waiting time encountered in traffic" is also ambiguous to a POSITA. As Dr. Mundy's declaration explains, there was a clear understanding of "waiting time" in the taxi industry in 1998, but not "waiting time encountered in traffic." (Ex. 3, Mundy Decl. at ¶¶ 67-68.) That's because to a POSITA, "waiting time" is the amount of time that a taxi is below a predefined speed threshold that was typically set by some sort of regulatory agency. (*Id*. at ¶¶ 64-67.) That time could be because of traffic (*e.g.*, congestion or an accident) or it could be because of some other reason (*e.g.,* the rider stopped by a convenience store to buy milk).

2. If this Term Is Construed, the Court Should Adopt Uber's Proposed Construction.

If this term is construed, Uber's proposed construction, "amount of time spent stopped or below a predefined speed threshold," is the proper construction as it is consistent with the intrinsic and extrinsic evidence. Although a POSITA would not recognize the term "waiting time encountered in traffic," the patent recites a similar phrase, "waiting time in traffic," when describing prior art taxi fares. (Ex. 1, '727 Patent, 1:24-26.) Thus, the intrinsic record suggests that this term can be construed consistent with the plain and ordinary meaning of "waiting time" for taxi fare calculation, which is Uber's proposed construction.

Dr. Mundy's declaration and other extrinsic evidence confirm that Uber's proposed construction is aligned with the plain and ordinary meaning of "waiting time" for taxi fare calculations. (Ex. 3, Mundy's Decl., ¶¶ 64-67.) For example, The New York City Taxicab Fact Book lists New York City taxi fares between 1952-2006, including fare calculation based on

initial charge, mileage charge, and wait time, as shown below. (Ex. 13, Schaller Consulting, March 2006, at 18, Table 2.)

Table 2. Taxi fares since 1952.

	Initial Charge	Mileage Charge	Wait Time	Charge per Mile	Charge per Minute	Avg. fare
Before 1952	$0.20 first 1/4 mi.	$0.05 per 1/4 mi.	$0.05 per 2 min.	$0.20	$0.03	$0.83
July 1952	$0.25 first 1/5 mi.	$0.05 per 1/5 mi.	$0.05 per 90 sec.	$0.25	$0.03	$1.06
Dec. 1964	$0.35 first 1/5 mi.	$0.05 per 1/5 mi.	$0.05 per 90 sec.	$0.25	$0.03	$1.16
Jan. 1968	$0.45 first 1/6 mi.	$0.10 per 1/3 mi.	$0.10 per 2 min.	$0.30	$0.05	$1.48
March 1971	$0.60 first 1/5 mi.	$0.10 per 1/5 mi.	$0.10 per 72 sec.	$0.50	$0.08	$2.30
Nov. 1974	$0.65 first 1/6 mi.	$0.10 per 1/6 mi.	$0.10 per 60 sec.	$0.60	$0.10	$2.71
March 1977	$0.75 first 1/7 mi.	$0.10 per 1/7 mi.	$0.10 per 60 sec.	$0.70	$0.10	$3.09
July 1979	$0.90 first 1/7 mi.	$0.10 per 1/7 mi.	$0.10 per 60 sec.	$0.70	$0.10	$3.24
April 1980	$1.00 first 1/9 mi.	$0.10 per 1/9 mi.	$0.10 per 45 sec.	$0.90	$0.13	$4.06
July 1984	$1.10 first 1/9 mi.	$0.10 per 1/9 mi.	$0.10 per 45 sec.	$0.90	$0.13	$4.16
May 1987	$1.15 first 1/8 mi.	$0.15 per 1/8 mi.	$0.15 per 60 sec.	$1.20	$0.15	$5.08
Jan. 1990	$1.50 first 1/5 mi.	$0.25 per 1/5 mi.	$0.25 per 75 sec.	$1.25	$0.20	$5.70
March 1996	$2.00 first 1/5 mi.	$0.30 per 1/5 mi.	$0.30 per 90 sec.	$1.50	$0.20	$6.85
May 2004	$2.50 first 1/5 mi.	$0.40 per 1/5 mi.	$0.40 per 120 sec.	$2.00	$0.20	$8.66
Nov. 2006	$2.50 first 1/5 mi.	$0.40 per 1/5 mi.	$0.40 per 60 sec.	$2.00	$0.40	$9.61

Surcharges and flat fares:

- A night surcharge, applying to trips beginning between 8 p.m. and 6 a.m., was added in May 1981. The surcharge was rescinded in January 1982 for all but the 2,300 fleet cabs. The 50-cent night surcharge was extended to the entire industry in May 1987.
- $1 surcharge for trips beginning between 4 p.m. and 8 p.m. was added in May 2004.
- A $30 flat fare from JFK airport to Manhattan was adopted in January 1996 and increased to $35 in 2001 and $45 in 2004. The flat fare was extended to trips from Manhattan to JFK airport in 2006.
- Surcharge for trips to Newark Airport was increased from $10 to $15 in 2004.

Average fare based on 2.9 mile trip with 4.77 minutes of waittime

Other extrinsic evidence is consistent with this understanding. (Ex. 14, DeseretNews, "Cabs Charge Not Only For Mileage But For The Time Spent At Red Lights," May 27, 1990, at 1-2 ("Once the cab is stopped, riders are charged by the second and not by the mile." … "Any speed under 9.6 mph starts the waiting time rate."); Ex. 15, EP 0 032 607 ("Baumann"), 6:11-16, ("The meter unit will permit fare rate structure adjustments using wire jumpers that determine the cents/minute, cents/mile, and threshold velocity (i.e. the point at which the instantaneous time fare rate is the same as the distance fare rate."); Ex. 16, Washington Post,

April 19, 2012 (https://www.washingtonpost.com/wp-srv/special/business/taxi-fares-compared/) ("…a charge for wait time, an additional cost the meter calculates when a cab is sitting idle or moving at slow speeds… .").)

* * * *

In sum, because Claim 12 specifies that the "waiting time" is "encountered in traffic," ambiguity is injected into this term rendering it indefinite. If the Court, however, determines that the term can be construed, then for the reasons above, it should be construed consistent with the plain and ordinary meaning of the term "waiting time," which is "amount of time spent stopped or below a predefined speed threshold."

Dated: October 6, 2022

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CERTIFICATE OF SERVICE

I hereby certify that on October 6, 2022, the foregoing was served upon counsel of record via electronic mail:

/s/ Melissa R. Smith
Melissa R. Smith

IN THE UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

FARE TECHNOLOGIES, LLC, Plaintiff, v. UBER TECHNOLOGIES, INC. d/b/a UBER, Defendant.	)	C.A. No. 6:22-cv-00317-ADA

DECLARATION OF LISA M. SCHOEDEL

I, Lisa M. Schoedel, declare the following:

1. I am an attorney at Jenner & Block, LLP, and am one of the attorneys representing Defendant Uber Technologies, Inc. d/b/a/ Uber ("Uber") in this case.

2. Exhibit 1 to this declaration is a true and correct copy of U.S. Patent No. RE46, 727.

3. Exhibit 2 to this declaration is a true and correct copy of the article "Uber Opens Up Platform To Non-Limo Vehicles With 'Uber-X,' Service Will Be 35% Less Expensive" by Alexia Tsotsis dated July 2, 2012, which can be found at: https://techcrunch.com/2012/07/01/uber-opens-up-platform-to-non-limo-vehicles-with-uber-x-service-will-be-35-less-expensive/.

4. Exhibit 3 to this declaration is a true and correct copy of the Declaration of Dr. Ray A. Mundy, D. Sc. In support of Uber's Opening Claim Construction Brief.

5. Exhibit 4 to this declaration is a true and correct copy of the book "Taxi! Urban economies and the social & transport impacts of the taxicab," by James M. Cooper, Ray Mundy, and John D. Nelson as provided to Uber by Dr. Mundy.

6. Exhibit 5 to this declaration is a true and correct copy of the article "Is the Fare Fair? Taximeter Testing in the 1920s and Today" from the NIST Museum and History Program, which can be found at: https://www.nist.gov/nist-museum/fare-fair-taximeter-testing-1920s-and-today.

7. Exhibit 6 to this declaration is a true and correct copy of Austin, Texas's Code § 13-2-401, which can be found at: ARTICLE 2. - GROUND TRANSPORTATION SERVICES. | Code of Ordinances | Austin, TX | Municode Library.

8. Exhibit 7 to this declaration is a true and correct copy of the definition of "taxi" found in the 1997 edition of the Oxford Desk Dictionary and Thesaurus, American Edition as found in Ex. 3001 of IPR2017-01865.

9. Exhibit 8 to this declaration is a true and correct copy of Paper 21, the Final Written Decision entered on January 25, 2019, in IPR2017-01865.

10. Exhibit 9 to this declaration is a true and correct copy of the article "How Taxi Meters Work" by Jamie Page Deaton, which can be found at: Measuring Distance and Time - How Taxi Meters Work | HowStuffWorks.

11. Exhibit 10 to this declaration is a true and correct copy of U.S. Patent No. 4,263,657.

12. Exhibit 11 to this declaration is a true and correct copy of U.S. Patent No. 4,409,685.

13. Exhibit 12 to this declaration is a true and correct copy of U.S. Patent No. 5,917,434.

14. Exhibit 13 to this declaration is a true and correct copy of "The New York City Taxicab Fact Book" by Schaller Consulting dated March 2006, which can be found at: http://www.schallerconsult.com/taxi/taxifb.pdf.

15. Exhibit 14 to this declaration is a true and correct copy of the article "Cabs Charge Not Only For Mileage But For The Time Spent At Red Lights" by DeseretNews dated May 27, 1990, which can be found at: https://www.deseret.com/1990/5/27/18864110/cabs-charge-not-only-for-mileage-but-for-the-time-spent-at-red-lights.

16. Exhibit 15 to this declaration is a true and correct copy of European Patent Publication No. 0 032 607.

17. Exhibit 16 to this declaration is a true and correct copy of the article "Metered taxicab fares in 40 major U.S. cities" by the Washington Post dated April 19, 2012, which can be found at: https://www.washingtonpost.com/wp-srv/special/business/taxi-fares-compared/.

18. Exhibit 17 to this declaration is a true and correct copy of the definition of "trip meter" found in the Motor Era Dictionary of Automotive Terms, which can be found at: https://www.motorera.com/dictionary/tr.htm.

19. Exhibit 18 to this declaration is a true and correct copy of Section 5.54 of the National Institute of Standards and Technology ("NIST") Handbook 44-2014, which can be found at: https://www.nist.gov/system/files/documents/2017/05/09/hb44-14-final-web.pdf.

I hereby declare under penalty of perjury that all statements made herein of my own knowledge are true and correct and that all statements made on information and belief are believed to be true and correct.

Executed: October 6, 2022 in Geneva, Illinois

/s/ Lisa M. Schoedel
Lisa M. Schoedel

Exhibit 1

US00RE46727E

(19) **United States**
(12) **Reissued Patent**
Pomerantz

(10) **Patent Number: US RE46,727 E**
(45) **Date of Reissued Patent: Feb. 20, 2018**

(54) **TAXI TRIP METER SYSTEM WITH INDICATION OF FARE AND DISTANCE VIOLATIONS**

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(72) Inventor: **David Pomerantz**, Plano, TX (US)

(73) Assignee: **Fare Technologies LLC**, Plano, TX (US)

(21) Appl. No.: **14/723,731**

(22) Filed: **May 28, 2015**

Related U.S. Patent Documents

Reissue of:
(64) Patent No.: **6,122,591**
Issued: **Sep. 19, 2000**
Appl. No.: **09/136,144**
Filed: **Aug. 18, 1998**

(51) **Int. Cl.**
G06G 7/78 (2006.01)
G01C 21/34 (2006.01)

(52) **U.S. Cl.**
CPC ***G01C 21/34*** (2013.01)

(58) **Field of Classification Search**
CPC G01C 21/34
USPC 701/410
See application file for complete search history.

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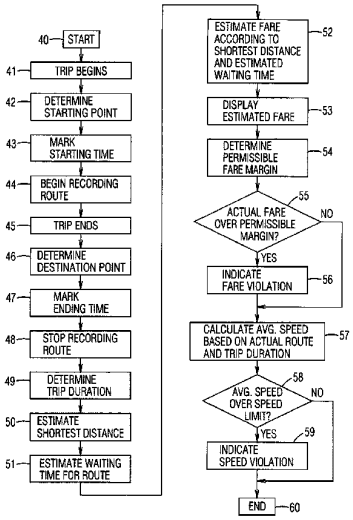
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Primary Examiner — Michelle Tarae
(74) *Attorney, Agent, or Firm* — Steven H. Washam; Washam PLLC

(57) **ABSTRACT**

A taxi trip meter system includes a taximeter and a location sensor connected to a computer loaded with street information and driver evaluation software. In a first embodiment, the estimated shortest route and distance between the starting and ending points of a trip are determined. If the estimated shortest trip distance is exceeded by an actual trip distance by a permissible margin, a distance violation is indicated. An actual average speed is calculated based on an actual trip duration and the actually traveled distance. If an estimated average speed limit for the actual route is exceeded by the actual average speed, a speed violation is indicated. In a second embodiment, an estimated taxi fare is calculated based on the estimated shortest route. If the estimated taxi fare is exceeded by an actual taxi fare calculated by the taximeter by a permissible margin, a fare violation is indicated.

40 Claims, 3 Drawing Sheets



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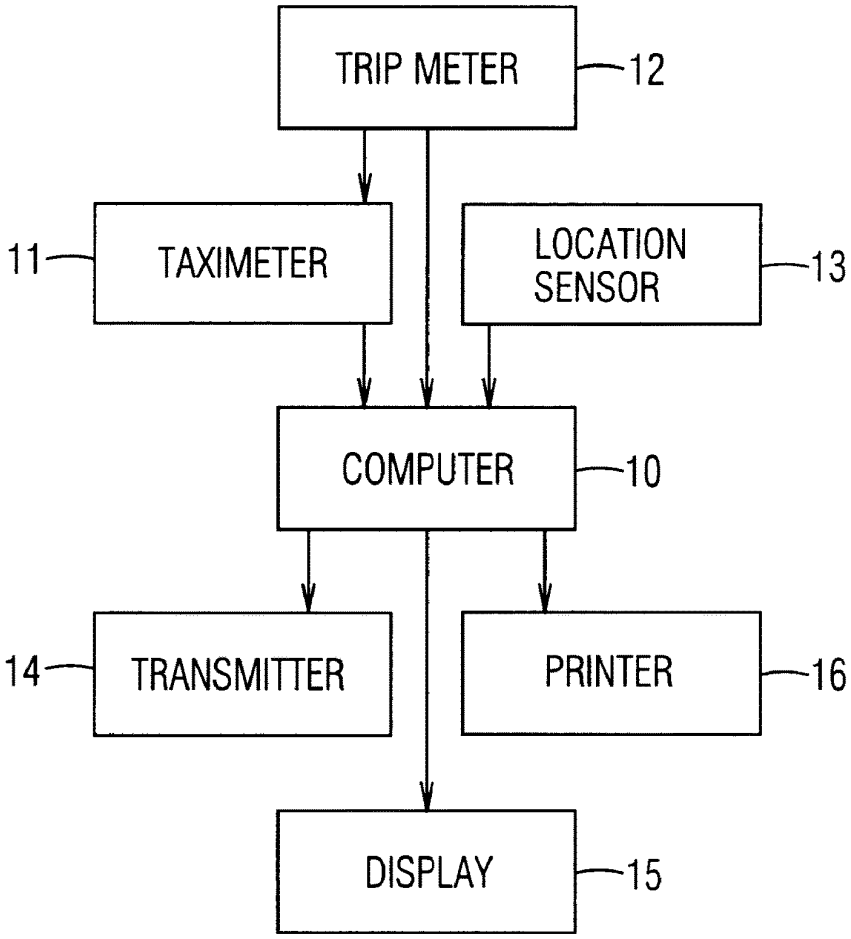

TRIP METER
12
11
TAXIMETER
LOCATION SENSOR
13
COMPUTER
10
14
TRANSMITTER
PRINTER
16
DISPLAY
15

Fig. 1

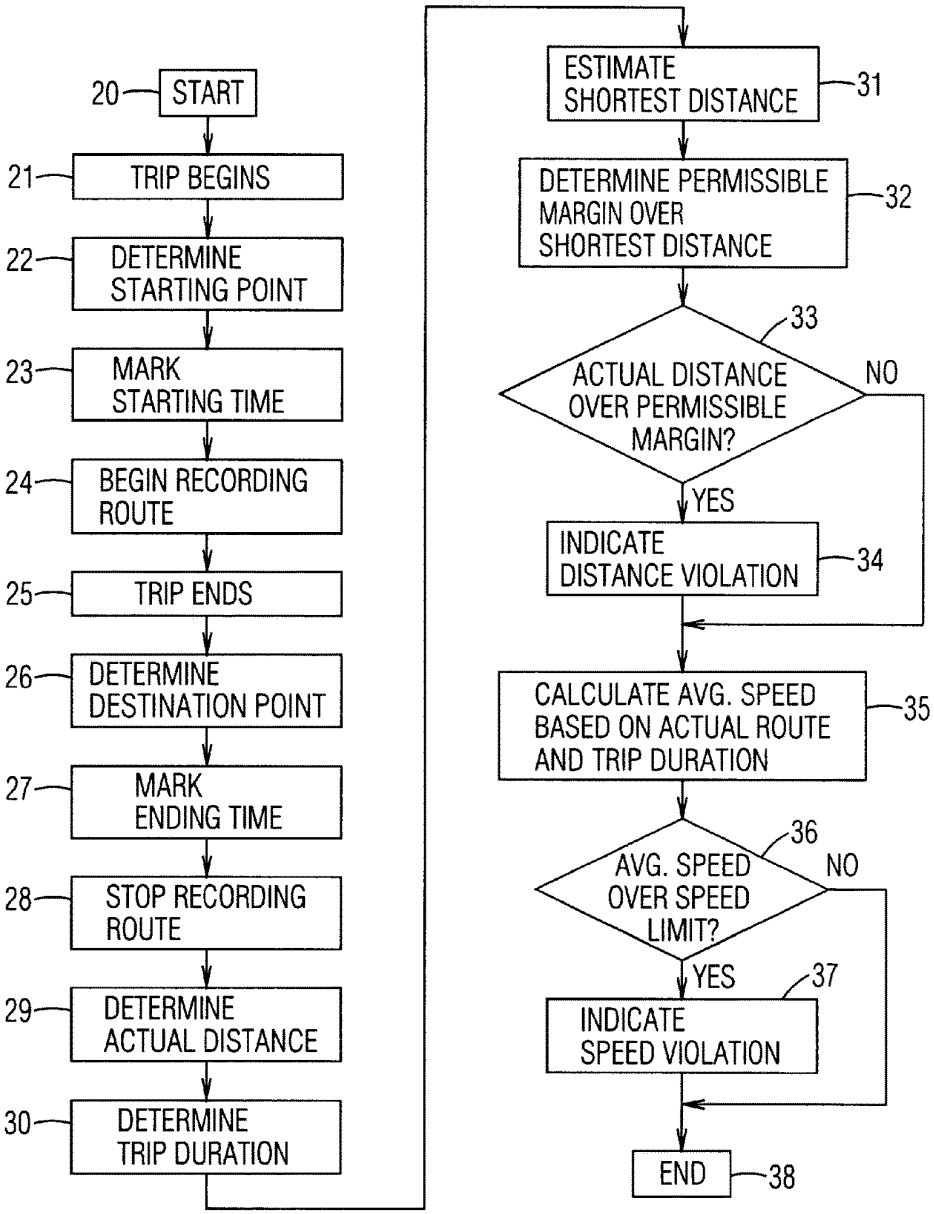

20
START
21
TRIP BEGINS
22
DETERMINE STARTING POINT
23
MARK STARTING TIME
24
BEGIN RECORDING ROUTE
25
TRIP ENDS
26
DETERMINE DESTINATION POINT
27
MARK ENDING TIME
28
STOP RECORDING ROUTE
29
DETERMINE ACTUAL DISTANCE
30
DETERMINE TRIP DURATION
ESTIMATE SHORTEST DISTANCE
31
DETERMINE PERMISSIBLE MARGIN OVER SHORTEST DISTANCE
32
33
ACTUAL DISTANCE OVER PERMISSIBLE MARGIN?
NO
YES
INDICATE DISTANCE VIOLATION
34
CALCULATE AVG. SPEED BASED ON ACTUAL ROUTE AND TRIP DURATION
35
36
AVG. SPEED OVER SPEED LIMIT?
NO
YES
37
INDICATE SPEED VIOLATION
END
38

Fig. 2

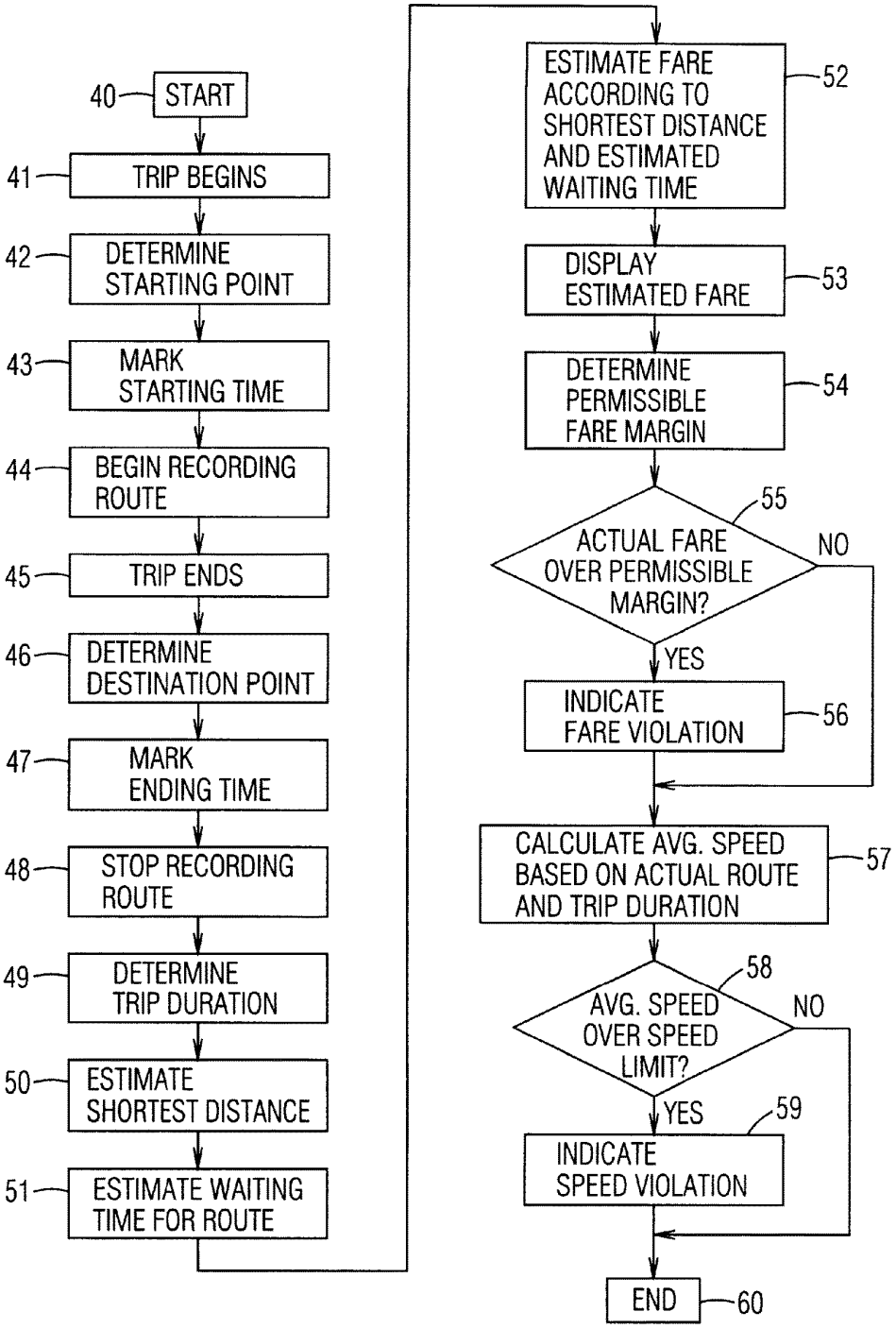

40
START
41
TRIP BEGINS
42
DETERMINE STARTING POINT
43
MARK STARTING TIME
44
BEGIN RECORDING ROUTE
45
TRIP ENDS
46
DETERMINE DESTINATION POINT
47
MARK ENDING TIME
48
STOP RECORDING ROUTE
49
DETERMINE TRIP DURATION
50
ESTIMATE SHORTEST DISTANCE
51
ESTIMATE WAITING TIME FOR ROUTE
52
ESTIMATE FARE ACCORDING TO SHORTEST DISTANCE AND ESTIMATED WAITING TIME
53
DISPLAY ESTIMATED FARE
54
DETERMINE PERMISSIBLE FARE MARGIN
55
ACTUAL FARE OVER PERMISSIBLE MARGIN?
NO
YES
56
INDICATE FARE VIOLATION
57
CALCULATE AVG. SPEED BASED ON ACTUAL ROUTE AND TRIP DURATION
58
AVG. SPEED OVER SPEED LIMIT?
NO
YES
59
INDICATE SPEED VIOLATION
END
60

Fig. 3

TAXI TRIP METER SYSTEM WITH INDICATION OF FARE AND DISTANCE VIOLATIONS

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a reissue of U.S. Pat. No. 6,122,591, which was issued on Sep. 19, 2000.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to taximeters.

2. Prior Art

A taxi fare is typically determined by a taximeter based on trip distance and waiting time in traffic. Taxi drivers are free to take whichever route they choose. Riders who are unfamiliar with the area being traversed are sometimes cheated by unscrupulous taxi drivers who take a roundabout route to inflate the fare. Other taxi drivers try to increase income by driving very fast to minimize travel time and thus increasing customer turnover, but at the expense of safety.

OBJECTS OF THE INVENTION

Accordingly, objects of the present taxi trip meter system are:

- to provide an estimated shortest trip distance for an estimated best route;
- to indicate a violation if the estimated shortest trip distance is exceeded by an actual trip distance by a permissible margin;
- to calculate an actual average speed for the trip;
- to indicate a violation if an estimated average speed limit for an actual travel route is exceeded by the actual average speed;
- to provide an estimated taxi fare based on the estimated shortest trip distance and an estimated waiting time in traffic; and
- to indicate a violation if the estimated taxi fare is exceeded by an actual taxi fare by a permissible margin.

Further objects of the present invention will become apparent from a consideration of the drawings and ensuing description.

BRIEF SUMMARY OF THE INVENTION

A taxi trip meter system includes a taximeter and a location sensor connected to a computer loaded with street information and driver evaluation software. In a first embodiment, the estimated shortest route and distance between the starting and ending points of a trip are determined. If the estimated shortest trip distance is exceeded by an actual trip distance by a permissible margin, a distance violation is indicated. An actual average speed is calculated based on an actual trip duration and the actually traveled distance. If an estimated average speed limit for the actual route is exceeded by the actual average speed, a speed violation is indicated. In a second embodiment, an estimated taxi fare is calculated based on the estimated shortest route. If the estimated taxi fare is exceeded by an actual taxi fare calculated by the taximeter by a permissible margin, a fare violation is indicated.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

FIG. **1** is a block diagram of the present taxi trip meter system.

FIG. **2** is a flowchart for a first embodiment of a method implemented by the taxi trip meter system.

FIG. **3** is a flowchart for a second embodiment of the method implemented by the taxi trip meter system.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1**: A first embodiment of the present taxi trip meter system is shown in FIG. **1**. It is mounted in a vehicle, e.g., a taxi, and includes a computer **10** receiving taxi fare information from a taximeter **11**, trip distance information from a trip meter **12**, and geographical location information from a location sensor **13**. Taximeter **11** also receives input from trip meter **12**. Computer **10** may be any type of programmable processor, and is preferably loaded with detailed street and highway information, e.g., from a CD-ROM street navigation program. Location sensor **13** may be any type of device that indicates the precise geographical location of the vehicle, such as a GPS (global positioning satellite) receiver. A radio transmitter **14**, a display **15**, and a printer **16** connected to computer **10** enable the output of driver evaluation information in different forms.

FIG. **2**: A first embodiment of a taxi trip meter method implement by the system of FIG. **1** is shown in FIG. **2**. It is preferably implemented as software or firmware in the computer. The process is started at block **20**. When a trip is begun at block **21**, e.g., when the taximeter is activated or a specific initiating input is provided to the computer, the geographical starting point is determined at block **22**, and the starting time is marked at block **23**. A recording of the actual route being traveled is begun at block **24**. When the vehicle has reached its destination and the trip is ended at block **25**, e.g. when the taximeter is deactivated or a specific terminating input is provided to the computer, the geographical destination point is determined at block **26**, and the ending time is marked at block **27**. The starting and ending points are determined with the location sensor and the street information loaded in the computer. The recording of the actual route is stopped at block **28**. The actual trip distance is determined at block **29** with input from the trip meter or with street information. The actual trip duration is determined at block **30** by calculating the difference between the starting and ending times. Alternatively, a timer may be employed.

Based on available street information, the optimal route and shortest trip distance between the starting and ending points are estimated at block **31** with any suitable method well known in the art. The shortest trip distance is preferably determined for an actual street route, but if the computer is not provided with street information, the straight-line distance between the starting and end points may be considered as the estimated shortest trip distance. A permissible margin over the estimated shortest trip distance is determined at block **32**. The margin may be a fixed percentage over the

estimated shortest distance, or it may be a variable percentage that is greater for shorter distances, or smaller for longer distances.

The actual trip distance is compared to the estimated shortest trip distance at block **33**. If the estimated shortest trip distance is exceeded by the actual trip distance by the permissible margin, a distance violation is indicated at block **34**. The indication for the violation may be provided in various forms, e.g., as a transmission to the taxi company headquarters through the transmitter, as information on the display, or as a printout from the printer. The taxi customer and the taxi company are thus notified of an excessively long route taken by the taxi driver. A powerful deterrent is thus provided against cheating by the taxi driver.

A further feature is provided for monitoring driving speed. The average actual speed for the trip is calculated at block **35** based on the actual trip distance and trip duration. If an estimated average speed limit for the actual route, which may be provided as part of the street information, is exceeded by the average actual speed at block **36**, a speed violation is indicated at block **37**. The process is ended at block **38**. A powerful deterrent is thus provided against speeding by the taxi driver.

FIG. **3**: A second embodiment of the taxi trip meter method implement by the system of FIG. **1** is shown in FIG. **3**. It is preferably implemented as software or firmware in the computer. The process is started at block **40**. When a trip is begun at block **41**, e.g., when the taximeter is activated or a specific initiating input is provided to the computer, the geographic starting point is determined at block **42**, and the starting time is marked at block **43**. A recording of the actual route being traveled is begun at block **44**. When the vehicle has reached the destination point and the trip is ended at block **45**, e.g. when the taximeter is deactivated or a specific terminating input is provided to the computer, the geographic destination point is determined at block **46**, and the ending time is marked at block **47**. The starting and ending points are determined with the location sensor and the street information loaded in the computer. The recording of the actual route is stopped at block **48**. The trip duration is determined at block **49** by calculating the difference between the starting and ending times. Alternatively, a timer may be employed.

Based on available street information, the optimal route and shortest trip distance between the starting and ending points are estimated at block **50** with any suitable method well known in the art. The shortest trip distance is preferably determined for an actual street route, but if the computer is not provided with street information, the straight-line distance between the starting and end points may be considered as the estimated shortest trip distance. An estimated waiting time in traffic along the optimal route is determined at block **51** based on location traffic information and the time of day to account for traffic lights, traffic congestion, etc. An estimated fare is determined at block **52** based on the estimated shortest trip distance and estimated waiting time, and displayed at block **53**. A permissible margin over the estimated fare is determined at block **54**. The margin may be a fixed percentage over the estimated fare, or it may be a variable percentage that is greater for lower fares, or smaller for higher fares.

An actual fare computed by the taximeter is compared to the estimated fare at block **55**. If the estimated fare is exceeded by the actual fare by the permissible margin, a fare violation is indicated at block **56**. The indication for the violation may be provided in various forms, e.g., as a transmission to the taxi company headquarters through the transmitter, as information on the display, or as a printout from the printer. The taxi customer and the taxi company are thus notified of an excessive fare charged by the taxi driver. A powerful deterrent is thus provided against cheating by the taxi driver.

A further feature is provided for monitoring driving speed. The actual average speed for trip is calculated at block **57** based on the actual trip distance and trip duration. If an estimated average speed limit for the actual route, which may be provided as part of the street information, is exceeded by the actual average speed at block **58**, a speed violation is indicated at block **59**. The process is ended at block **60**. A powerful deterrent is thus provided against speeding by the taxi driver.

SUMMARY AND SCOPE

Accordingly, a taxi trip meter system is provided. It provides an estimated shortest trip distance. It indicates a distance violation if the estimated shortest trip distance is exceeded by an actual trip distance by a permissible margin. It calculates an actual average speed for the trip. It indicates a speed violation if an estimated average speed limit for the actual route is exceeded by the actual average speed. It provides an estimated fare based on the estimated shortest trip distance and an estimated waiting time. It indicates a fare violation if the estimated fare is exceeded by an actual fare by a permissible margin.

Although the above description is specific, it should not be considered as a limitation on the scope of the invention, but only as an example of the preferred embodiment. Many substitutes and variations are possible within the teachings of the invention. For example, the starting and ending points may be inputted before the trip to provide advance notice of the fare. The estimated fare based on the optimal route may be used as the actual fare to completely eliminate the possibility of cheating. The trip meter may be eliminated, and the trip distance may be determined with GPS and map data. When a violation is indicated, the recorded route may be reviewed by the taxi company or government authority for excusable causes, such as accidents, parades, road closures, etc. A printed ticket may be provided for the customer for subsequent resolution with the taxi company. The fares calculated by the taximeter and the taxi trip meter system may be considered as including distance information. The trip meter may be indirectly connected to the computer through the taximeter. Therefore, the scope of the invention should be determined by the appended claims and their legal equivalents, not by the examples given.

I claim:

1. A taxi trip meter system for a taxi, comprising:

a computer;

a trip meter connected to said computer, said trip meter for measuring an actual trip distance traveled by said taxi between a starting point and a destination point;

a location sensor providing geographical location information about said taxi to said computer; and

instructions loaded in said computer instructing said computer to calculate an estimated shortest trip distance between said starting point and said destination point, to compare said estimated shortest trip distance with said actual trip distance, and to indicate a distance violation when said estimated shortest trip distance is exceeded by said actual trip distance by a predetermined distance margin.

2. The taxi trip meter system of claim **1**, wherein said location sensor comprises a GPS receiver.

3. The taxi trip meter system of claim 1, further including a transmitter connected to said computer for transmitting violation information.

4. The taxi trip meter system of claim 1, further including a display connected to said computer for displaying violation information.

5. The taxi trip meter system of claim 1, further including a printer connected to said computer for printing violation information.

6. The taxi trip meter system of claim 1, further including a taximeter connected to said computer, and instructions instructing said computer to calculate an estimated taxi fare for said estimated shortest trip distance, and to compare said estimated taxi fare to an actual taxi fare calculated by said taximeter for said actual trip distance, and to indicate a fare violation when said estimated taxi fare is exceeded by said actual taxi fare by a predetermined fare margin.

7. A taxi trip distance violation detection method, comprising:

determining a starting point for a trip;

determining a destination point for said trip;

determining an estimated shortest trip distance between said starting point and said destination point;

determining an actual trip distance traveled by a vehicle after said trip is completed;

comparing said estimated shortest trip distance with said actual trip distance; and

indicating a distance violation when said estimated shortest trip distance is exceeded by said actual trip distance by a predetermined distance margin.

8. The taxi trip distance violation detection method of claim 7, wherein said estimated shortest trip distance comprises a driving distance through known roads.

9. The taxi trip distance violation detection method of claim 7, wherein said estimated shortest trip distance comprises a straight line distance between said starting point and said destination point.

10. The taxi trip distance violation detection method of claim 7, further including determining an actual trip duration after said trip is completed, determining an actual average speed, determining an estimated average speed limit for an actual route traveled during said trip, and indicating a speed violation when said estimated average speed limit is exceeded by said actual average speed.

11. The taxi trip distance violation detection method of claim 7, further including recording an actual route traveled during said trip for subsequent review for excusable causes for said distance violation.

12. [A] *An automated* taxi fare estimating method, comprising:

using a computer including street information accessible thereon, the computer including program instructions to receive geographical location information from at least one network connected location sensor and to access the street information based on the received geographical location information, the computer program instructions comprising:

receiving geographical location information from the at least one location sensor;

determining a starting point for a trip *based on the received geographical location information*;

determining a destination point for said trip;

determining an estimated shortest trip distance between said starting point and said destination point *based on the street information or on a straight-line distance determined between the starting point and destination point*;

determining an estimated waiting time encountered in traffic during said trip *based on the geographical location information and the street information*; and

determining an estimated taxi fare based on said estimated shortest trip distance and said estimated waiting time.

13. The taxi fare estimating method of claim 12, wherein said estimated shortest trip distance comprises a driving distance through known roads.

[14. The taxi fare estimating method of claim 12, wherein said estimated shortest trip distance comprises a straight line distance between said starting point and said destination point.]

15. The taxi fare estimating method of claim 12, further including determining an actual taxi fare with a taximeter for an actual trip distance traveled during said trip, comparing said estimated taxi fare to said actual taxi fare, and indicating a fare violation when said estimated taxi fare is exceeded by said actual taxi fare by a predetermined fare margin.

16. The taxi fare estimating method of claim 12, further including determining an actual trip duration after said trip is completed, determining an actual average speed, determining an estimated average speed limit for an actual route traveled during said trip, and indicating a speed violation when said estimated average speed limit is exceeded by said actual average speed.

17. The taxi fare estimating method of claim 12, further including recording an actual route traveled during said trip for subsequent review for excusable causes for said fare violation.

18. The taxi trip meter system of claim 1 wherein the computer is in network communication with the trip meter.

19. The taxi fare estimating method of claim 12 wherein the estimated taxi fare is determined on a remote computer in network communication with a taxi trip meter.

20. The taxi fare estimating method of claim 12 wherein the estimated shortest trip distance is determined using the geographical location information.

21. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the estimated taxi fare determination is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

22. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an estimated vehicle speed using the geographical location information;

determining the estimated shortest trip distance and the estimated waiting time using the geographical location information; and

wherein the estimated taxi fare determination is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

23. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the fare is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

24. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the fare is based on the estimated distance traveled when the estimated vehicle speed exceeds a predetermined speed and on the estimated waiting time when the estimated vehicle speed does not exceed the predetermined speed.

25. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an estimated vehicle speed using the geographical location information;

determining an estimated driving distance using the geographical location information; and

wherein the fare is based on the estimated shortest trip distance, the estimated waiting time, the estimated driving distance, and the estimated vehicle speed.

26. The taxi fare estimating method of claim 12, wherein the estimated waiting time is determined using route information available on a computer, wherein the route information includes traffic light or traffic congestion information.

27. The taxi fare estimating method of claim 12, wherein a computer determines the fare from a remote location and communicates the fare over a network connection.

28. The taxi fare estimating method of claim 12, the method steps further comprising:

communicating the estimated fare to a rider upon or after completion of the trip.

29. The taxi fare estimating method of claim 12, the method steps further comprising:

determining an actual fare based upon an actual trip distance or an actual trip duration; and

indicating a fare violation if the actual fare exceeds the estimated fare by a predetermined permissible margin.

30. An automated taxi trip meter system, the system comprising:

a computer in network communication with at least one location sensor, the computer including street information accessible thereon and program instructions for performing the program steps comprising:

receiving geographical location information from the at least one location sensor;

determining a starting point for a trip based on the geographical location information;

determining a destination point for the trip;

accessing the street information using the geographical location information;

determining an estimated shortest trip distance between the starting point and the destination point based on the street information or on a straight-line distance determined between the starting point and destination point;

determining an estimated waiting time in traffic during the trip based on the street information; and

determining an estimated fare based on the estimated shortest trip distance and the estimated waiting time.

31. The taxi trip meter system of claim 30 wherein the estimated waiting time is determined using the geographical location information.

32. The taxi trip meter system of claim 30, the program steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the estimated taxi fare determination is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

33. The taxi trip meter system of claim 30, the program steps further comprising:

determining an estimated vehicle speed using the geographical location information;

determining the estimated waiting time using the geographical location information; and

wherein the estimated taxi fare determination is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

34. The taxi trip meter system of claim 30, the program steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the fare is based on the estimated shortest trip distance, the estimated waiting time, and the estimated vehicle speed.

35. The taxi trip meter system of claim 30, the program steps further comprising:

determining an estimated vehicle speed using the geographical location information; and

wherein the fare is based on the estimated distance traveled when the estimated vehicle speed exceeds a predetermined speed and on the estimated waiting time when the estimated vehicle speed does not exceed the predetermined speed.

36. The taxi trip meter system of claim 30, the program steps further comprising:

determining an estimated vehicle speed using the geographical location information;

determining an estimated driving distance using the geographical location information; and

wherein the fare is based on the estimated shortest trip distance, the estimated waiting time, the estimated driving distance, and the estimated vehicle speed.

37. The taxi trip meter system of claim 30, wherein the estimated shortest trip distance is determined using actual street route information available on the computer.

38. The taxi trip meter system of claim 30, wherein the estimated waiting time is determined using route information available on the computer, wherein the route information includes at least one of traffic light or traffic congestion information.

39. The taxi trip meter system of claim 30, wherein the computer determines the fare from a remote location and communicates the fare over a network connection.

40. The taxi trip meter system of claim 30, the program steps further comprising:

communicating the estimated fare to a rider upon or after completion of the trip.

41. The taxi trip meter system of claim 30, the program steps further comprising:

determining an actual fare based upon an actual trip distance or an actual trip duration; and

indicating a fare violation if the actual fare exceeds the estimated fare by a predetermined permissible margin.

* * * * *

Exhibit 2

Uber Opens Up Platform To Non-Limo Vehicles With "Uber X," Service Will Be 35% Less Expensive

Alexia Tsotsis@alexia / 12:10 AM EDT•July 2, 2012

Save

Comment

Declaring its independence from the traditional Lincoln Town Car (sorry, couldn't resist), Uber is going beyond black cars this Fourth of July, bringing its up until now secret "Uber X" project public.

"Uber X" will allow Uber partners to use its dispatching software in order to dole out vehicles beyond Lincoln Town Cars, giving passengers a choice between Toyota Prius Hybrids and SUVs like the Cadillac Escalade, etc.

"Our motto is 'Everyone's Private Driver'," CEO Travis Kalanick tells me, explaining that the law in California doesn't specify a car type for "limo" companies. A "limo" company must have a TCP license in order to transport people for money, but isn't necessarily committed to using limos and/or the traditional black cars we've associated with the service.

Already at least one Uber partner has traded in their Town Cars for hybrids Kalanick says, which is probably a smart plan considering Lincoln stopped making the Town Car model in 2011.

When asked whether this was a reaction to inevitably scarcity of Town Cars post-discontinuation, Kalanick said absolutely not, "This is the first expansion of the platform. It's ice cream trucks next week, it was BBQ in Austin for SXSW. Uber is ultimately a cross between lifestyle and logistics. Lifestyle is 'Give me what I want', logistics is 'How do I get it?'".

Kalanick wouldn't reveal further details about the company's plans for expansion or whether an API was coming out soon.

When asked if the new vehicle types would essentially make Uber a taxi dispatch service like GetTaxi or MyTaxi, Kalanick also said no, "The difference is that you can also hail a taxi, with an Uber you have a pre-arranged situation, you have the driver's name and phone number."

Still, this loose definition leaves open the possibility for taxi services eventually converting to Ubers. In fact, the company works with taxis in Chicago. "We have hundreds of taxis on the system," Kalanick says.

The pricing for Uber X rides will be a $5 base fee, with a $3.25 per-mile charge there afterward. This is 35% cheaper than Uber's current black car rates and will open the service up to a more price-conscious clientele.

While the Uber X launch means that the service as of Wednesday will have rates competitive to taxis and ride sharing services like Lyft, Kalanick emphasizes that all Uber partners old and new have commercial insurance and commercial licences. “It remains to be seen whether regulators will crack down [on ridesharing], If they don’t, Uber is more than happy to play in the space.”

Exhibit 3

IN THE UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

FARE TECHNOLOGIES, LLC, Plaintiff, v. UBER TECHNOLOGIES, INC. d/b/a UBER, Defendant.	)	C.A. No. 6:22-cv-00317-ADA

DECLARATION OF DR. RAY A. MUNDY, D.Sc.

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VII. ADDITIONAL REMARKS 25

I, Ray A. Mundy, D.Sc. of Columbus, OH, declare that:

I. INTRODUCTION

1. My name is Ray A. Mundy, and I have been retained by counsel for Defendant Uber Technologies, Inc. ("Uber" or "Defendant") as an expert witness to provide my opinion regarding the claim construction of certain terms found in the asserted claims of U.S. Patent No. RE46,727 ("the '727 Patent"). I have personal knowledge of the facts and opinions set forth in this declaration and believe them to be true. If called upon to do so, I would testify competently thereto.

2. I am being compensated for my time at my standard litigation consulting rate of $350 per hour, $4,000 for my first ten hours related to testimony and $400 per hour for any additional time related to testimony. I am also being reimbursed for expenses that I incur during the course of this work. My compensation is not contingent upon the results of my opinions, the substance of my opinions, or the outcome of any proceeding involving the challenged claims. I have no financial interest in the outcome of this matter or on the pending litigation between Plaintiff and Defendant. No part of my compensation depends on the outcome of this case or on the opinions that I render.

3. My analysis here is based on my years of education, research and experience, as well as my investigation and study of relevant materials, including those cited herein.

4. I may rely upon these materials, my knowledge and experience, and/or additional materials to rebut arguments raised by the Plaintiff. Further, I may also consider additional documents and information in forming any necessary opinions, including documents that may not yet have been provided to me.

5. My analysis of the materials produced in this proceeding is ongoing and I will continue to review any new material as it is provided. This declaration represents only those opinions I have formed to date. I reserve the right to revise, supplement, and/or amend my opinions stated herein based on new information and on my continuing analysis of the materials already provided.

II. BACKGROUND AND QUALIFICATIONS

6. I earned my Bachelor of Arts degree in General Business from Bowling Green State University in 1966. In 1967, I earned my M.B.A. in Management also from Bowling Green State University. I earned my Doctor of Science in Transportation and Logistics from Pennsylvania State University, with my dissertation being on "U.S. and Canadian Urban Mass Transportation Systems: A Comparative Empirical Analysis."

7. I received my B.A. in General Business, from Bowling Green State University in 1966, my M.B.A. in Management from Bowling Green State University in 1967 with a minor in Statistics, and my Ph.D. in Transportation and Logistics from Pennsylvania State University in 1973 with a minor in Marketing, Management, and Social Psychology.

8. I was the Barriger Endowed Professor at the Center for Transportation Studies of the University of Missouri-St. Louis from 2000 until 2018. Prior to that, I was the Taylor Distinguished Professor of Logistics and Transportation at the University of Tennessee from 1996-2000. I also taught at Bowling Green State University, Eastern Michigan University, Lycoming College and Pennsylvania State University. I have taught courses in Domestic Transportation and Supply Chain Management for both the graduate and undergraduate levels at the University of Missouri-St. Louis. Over the years, I have also taught courses with Executive in Residence, Introduction to Business, Introduction to Logistics, Introduction to Transportation, Management,

Marketing, National Transportation Policy, Organizational Development, Organizational Theory, Personnel, Process Management, Production, Statistics, Traffic Management and Urban Transportation. A true and correct copy of my curriculum vitae is attached hereto as Exhibit A, which details my education, academic experience, instructional responsibilities, publications, scholarly research, honors, grants, awards, work in review and development, presentations, reports and service activities.

9. I have conducted a full range of economic, regulatory, managerial and physical studies specifically aimed at private sector transportation industry, including taxicabs. I have completed numerous private sector transportation industry analyses for the U.S. and Canadian airports and private sector transportation industry operators at over thirty-five U.S. and Canadian airports or cities.

My major areas of service and studies are in the following types of analyses:

- Analysis of administrative/regulatory options available to managing private sector transportation industry: Analysis of federal, state, and local transportation legislation as it applies to a specific airport or city. State and local laws, regulations, and ordinances are not uniform and often must be altered to initiate new types of private sector transportation industry services such as ride-hailing and other forms of app based transportation services.
- Evaluating current operations: Analysis of the current performance of existing private sector transportation industry operations, their economic conditions, administrative procedures, and regulatory environment. Studies include all forms of private sector transportation industry vehicles including taxi, sedan (black car),

van, limousine, minibus, and bus in all forms of operating modes - demand responsive, door-to-door shared-ride and premium ride, and line haul.

- Simulation of vehicles necessary to serve demand: Analysis of passenger demand, number, and operational configuration of vehicles necessary to service that demand in whatever waiting time the airport administration would set as contract specifications.
- Development of remote private sector transportation industry terminals: Analysis of effects that the evolution of remote airport private sector transportation industry terminals would have on airport revenues, traffic congestion, curb utilization, and parking.
- Curb prioritization and concession fees: Analysis of appropriate fees to charge various private sector transportation industry providers given industry and local regulatory practices and how these services should be offered and marketed on the airport curb.

10. I have knowledge of the city and airport private sector transportation industry through my position as Director Emeritus of the Center for Transportation Studies at the University of Missouri - St. Louis and through my affiliation as Executive Director for the Airport Ground Transportation Association ("AGTA"). In my AGTA capacity, I have conducted two national conferences each year since 1976, one dedicated to the administration and regulation of airport private sector transportation and a second on managerial aspects of the private sector transportation serving airports.

11. I publish the monthly AGTA Newsletter, *Insights*, which summarizes and provides opinions on the current newspaper articles, academic and technical studies, and major industry

trends. I also publish an industry summary of weekly events called "Curbs."

12. I have published articles on taxicab simulation, remote airport private sector transportation industry terminals, and management of the airport private sector transportation industry. My most recent book regarding taxis was published in 2010, Taxi! Urban Economies and the Social and Transport Impacts of the Taxicab, by James Cooper, Ray Mundy and John Nelson, Ashgate Publishing (2010).

13. My most recent publication regarding taxis and ride-hailing was in March 2018. This was a U.S. Department of Transportation research report entitled "*Why TNCs Will Be Regulated Like Taxis, Historically Speaking*," https://intrans.iastate.edu/research/completed/why-tncs-will-be-regulated-like-taxis/.

14. I have also served as an expert in certain legal proceedings. In the last five years, the only expert testimony has been my declaration on behalf of the defendants opposing plaintiff's motion for class certification in the litigation *Francisco Gonzales v. San Gabriel Transit, Inc.*, Case No. BC536584, in the California Superior Court, Los Angeles County.

III. LEVEL OF ORDINARY SKILL IN THE ART

15. In rendering the opinions set forth in this Declaration, I was asked to consider the patent claims through the eyes of a person of ordinary skill in the art ("POSITA") at the time of the invention, which I understand is August 18, 1998. I understand that the factors considered in determining the ordinary level of skill in a field of art include the level of education and experience of persons working in the field; the types of problems encountered in the field; the teachings of the prior art, and the sophistication of the technology at the time of the alleged invention. I understand that a POSITA is not a specific real individual, but rather is a hypothetical individual having the qualities reflected by the factors above. I understand that a POSITA would also have

knowledge from the teachings of the prior art, including the art cited below.

16. Taking these factors into consideration, on or before August 18, 1998, a POSITA relating to the technology of the '727 Patent would have had working industry knowledge of the taxicab and the transportation industry.

17. Before 1998, my level of skill in the art was at least that of a POSITA. I am qualified to provide opinions concerning what a POSITA would have known and understood at that time, and my analysis and conclusions herein are from the perspective of a POSITA as of that date.

IV. MATERIALS RELIED UPON

18. In reaching the conclusions described in this Declaration, I have relied on the documents and materials cited herein, including the '727 Patent, its prosecution history, and references cited herein. Each of these materials is a type of document that experts in my field would have reasonably relied upon when forming their opinions. When quoting from these materials, all emphasis is added unless otherwise noted.

19. I have also relied on my education, training, research, knowledge, and personal and professional experience in the relevant technologies and systems that were already in use prior to, and within the timeframe of the earliest priority date of the claimed subject matter in the '727 Patent, which is August 18, 1998.

V. LEGAL STANDARDS RELATING TO CLAIM CONSTRUCTION

20. I am not an attorney or a patent attorney and offer no opinions on the law. I have, however, been informed by counsel regarding various legal standards that may apply to this case, and I have applied those standards where necessary in arriving at my conclusions. Those legal standards provided by counsel are set forth herein.

21. I understand that patent claims are construed from the viewpoint of a POSITA of the patent at the time of the invention. I have been told that patent claims generally should be interpreted consistent with their plain and ordinary meaning as understood by a POSITA in the relevant time period (*i.e.*, at the time of the invention, or the so called "effective filing date" of the patent application), after reviewing the patent claim language, the specification and the prosecution history (*i.e.*, the intrinsic record). I have been informed that the effective filing date is August 18, 1998 for this case.

22. I further understand that a POSITA must read the claim terms in the context of the claim itself, as well as in the context of the entire patent specification. I understand that in the specification and prosecution history, the patentee may specifically define a claim term in a way that differs from the plain and ordinary meaning. I understand that the prosecution history of the patent is a record of the proceedings before the U.S. Patent and Trademark Office, and may contain explicit representations or definitions made during prosecution that affect the scope of the patent claims. I understand that an applicant may, during the course of prosecuting the patent application, limit the scope of the claims to overcome prior art or to overcome an examiner's rejection, by clearly and unambiguously arguing to overcome or distinguish a prior art reference, or to clearly and unambiguously disavow claim coverage.

23. In interpreting the meaning of the claim language, I understand that a POSITA may also consider "extrinsic" evidence, including expert testimony, inventor testimony, dictionaries, technical treatises, other patents, and scholarly publications. I understand this evidence is considered to ensure that a claim is construed in a way that is consistent with the understanding of those of skill in the art at the time of the claimed invention. This can be useful for technical terms whose meaning may differ from its ordinary English meaning. I understand that extrinsic evidence

may not be relied on if it contradicts or varies the meaning of claim language provided by the intrinsic evidence, particularly if the applicant has explicitly defined a term in the intrinsic record.

24. I understand that Section 112 of the Patent Laws requires that a patent claim particularly point out and distinctly claim the subject matter that the applicant regards as his or her invention. I understand that a patent is invalid for indefiniteness if its claims fail to inform, with reasonable certainty, a person of ordinary skill in the art about the scope and bounds of the invention. I understand that a claim is indefinite if its scope is not clear enough that a person of ordinary skill in the art could determine whether a particular embodiment infringes the claim or not. I also understand that when considering whether or not a claim is indefinite, a person of ordinary skill in the art will consider both the intrinsic and extrinsic record.

VI. THE '727 PATENT DISPUTED CLAIM TERMS

A. "Taxi" (Claim 1)

25. The term "taxi" is found in three places in claim 1 of the '727 Patent. First, the term "taxi" is used in the preamble of the claim: "A taxi trip meter system for a ***taxi***, … ." Then, the term "taxi" is found in the phrase: "a trip meter connected to said computer, said trip meter for measuring an actual trip distance traveled by said ***taxi*** between a starting point and a destination point." Then it is found in the following phrase: "a location sensor providing geographical location information about said ***taxi*** to said computer." These claim phrases do not provide a definition of taxi.

26. According to the '727 Patent, a taxi is a vehicle. "FIG. 1: A first embodiment of the present taxi trip meter system is shown in FIG. 1. It is mounted in a vehicle, e.g., a taxi." (Ex. 1, Column 2, lines 21-26.) A POSITA, however, understands that a taxi is a special type of vehicle.

27. As I described in my book Taxi! Urban Economies and the Social and Transport

Impacts of the Taxicab, the term "taxi" likely originated from the German word "taxemeter," which means the meter designed to measure tax (i.e., the fare) that was invented by Wilhelm Bruhn in 1891. (Ex. 4, page 11.) In 1907, taximeters were required in the London fleet, resulting in the use of the word "taximeter" to describe the device used in taxicabs that determines taxi fares. (Ex. 4, page 15.) A taximeter uses a regulated tariff and inputs in terms of time and distance traveled to determine the fare.

28. "The taxicab is the oldest form of licensed public transportation in the world, with the first licensing of taxis traceable to the Seventeenth century." (Ex. 4, page 7.) Today, taxis are still highly regulated common carrier vehicles. Licensing authorities, such as the New York City Taxi and Limousine Commission, define what constitutes a taxi or taxicab. Taxis are licensed to protect the public interest by providing standards for quantity control, quality control, and economic control, referred to as QQE. (Ex. 4, page 35.)

29. In contrast to taxis, negotiated fee carriers, such as limousines, provide prearranged rides and are referred to as contract carriers. For example, "non-metered sedans known as Black Car services" are found in New York City. (Ex. 4, page 63.) These are private for hire vehicles that may have set fares, such as a trip to Kennedy Airport, or time based for weddings, funerals, and proms. Such rates vary from time of day, holidays, and weather. Such carriers use a "market based" approach in determining the fare, which considers numerous factors such as time of day, competition, competitive demand, area to which the vehicle is travelling to, etc.

30. The Oxford Desk Dictionary and Thesaurus (American ed. 1997) defines taxi as an "automobile licensed for hire and usu. fitted with a meter." (Ex. 7, page 821 (abbreviating "usually" as "usu.").) This definition is accurate for the 1998 timeframe, where the vehicles not fitted with a meter would be a negotiated fee carrier, such as a limousine or Black Car service.

31. This language is also similar to the 1992 Austin Municipal Code Subpart N § 13-2-401, which provides that: "Taxicab service consists of service that operates on irregular routes and schedules on a call-and-demand basis, for compensation for that is usually determined by a taximeter." (Ex. 6.)

32. I describe in my book that while regulatory definitions for taxi varies by region, in the United States, taxis are typically defined in a similar manner as the Hillsborough County regulations. (Ex. 4, page 53.) The Hillsborough County regulatory definition is "any motor-driven vehicle, equipped with a taximeter with a capacity for 6 or less passengers, including the driver." Ex. 4, page 54.)

33. A POSITA would understand that a taxi is an automobile licensed for hire as a taxi or taxicab and fitted with a meter. Both the license and meter requirements are necessary to the definition of taxi.

B. "Trip Meter" (Claim 1)

34. The term "trip meter" is found in claim 1 of the '727 Patent. Specifically, it is found in the phrase "a ***trip meter*** connected to said computer, said ***trip meter*** for measuring an actual trip distance traveled by said taxi between a starting point and a destination point." The claim language provides that the trip meter measures actual distance traveled.

35. The '727 Patent describes a taxi trip meter system with respect to Figure 1. In particular, the taxi trip meter system "is mounted in a vehicle, e.g., a taxi, and includes a computer 10 receiving taxi fare information from a taximeter 11, ***trip distance information from a trip meter 12***, and geographical location information from a location sensor 13. Taximeter 11 also receives input from ***trip meter 12***." (Ex. 1, Column 2, lines 21-27 (emphasis added)). Figure 1 depicts the trip meter using reference number 12 as highlighted in Figure 1 below.

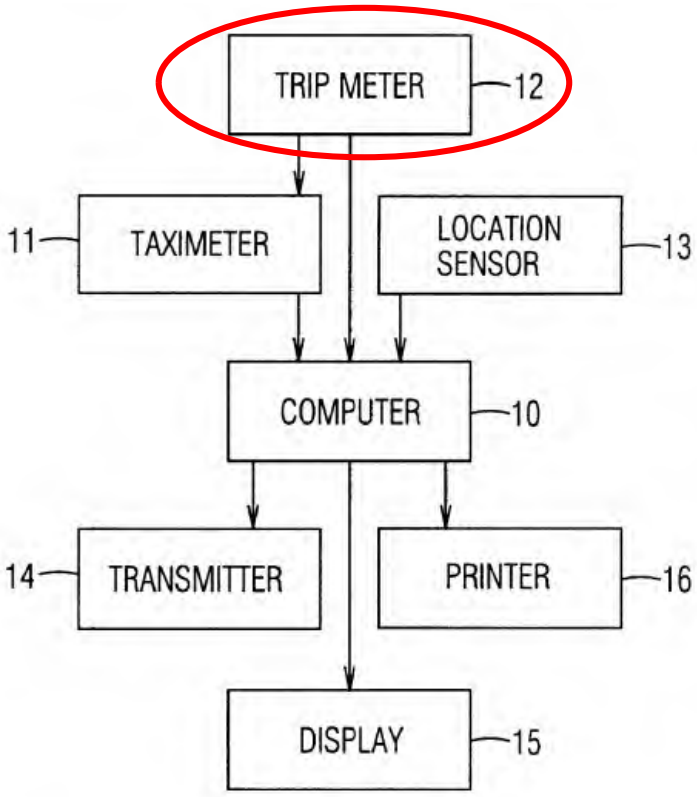


Fig. 1

36. The '727 Patent describes determining actual trip distance with respect to Figure 2. In particular, "[t]he actual trip distance is determined at block 29 with input from the ***trip meter*** or with street information." (Ex. 1, Column 2, lines 52-54 (emphasis added).) This sentence distinguishes determining distance using a trip meter as opposed to using street information. The '727 Patent explains that a "trip meter may be eliminated" from the taxi trip meter system when "the trip distance [is] determined with GPS and map data." (Ex. 1, Column 4, lines 37-39.)

37. Figure 2 is shown below with block 29 highlighted.

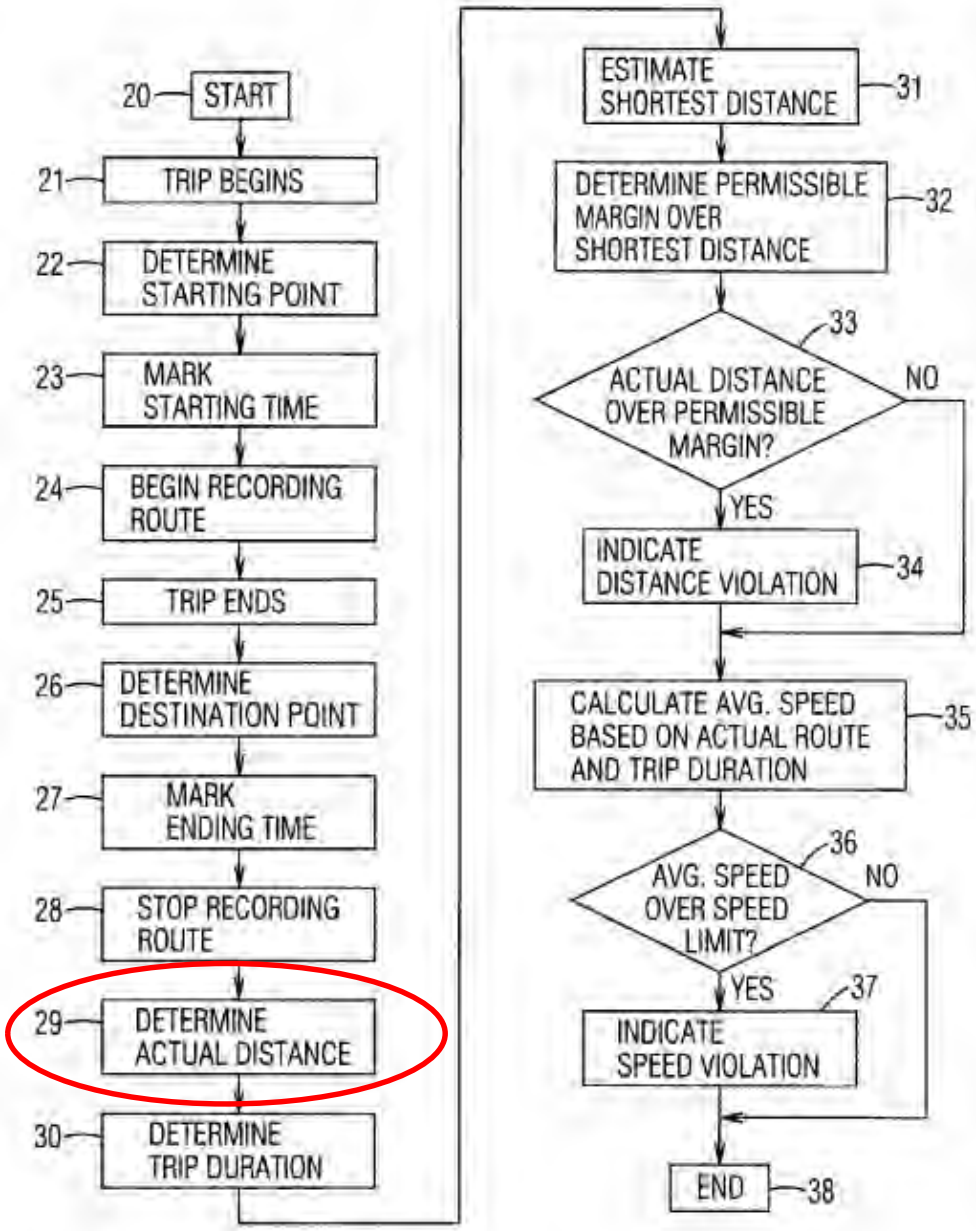


Fig. 2

38. Claim 1 uses a trip meter for measuring an actual trip distance traveled by a taxi, rather than with GPS and map data. Other than the fact that it can determine distance, the '727 Patent does not explain what a trip meter is.

39. A POSITA is very familiar with a trip meter, which is the part of a taximeter that

calculates the distance traveled during a taxi ride. In 1998, a trip meter was a very specific device used in a taxi that received an input from the vehicle that could be used to calculate distance. At that time, a trip meter was usually a mechanical device that counted the number of sprocket rotations.

40. As described in National Institute of Standards and Technology (NIST) Museum and History Program, "Is the Fare Fair? Taximeter Testing in the 1920s and Today," a trip meter first used a cable attached to the non-driving wheel. (Ex. 5, page 3.) Because of problems that occurred with that method, the meter then was designed to be attached to the taxi's transmission. (Ex. 5, page 3.)

41. My understanding and this history is consistent with patents that issued before 1998. For example, during prosecution of the originally issued patent, US Patent No. 6,122,591, the Patent Office rejected the originally filed claims based on US Patent No. 5,917,434 ("Murphy"). Murphy describes mileage meters for taxicabs. (Ex. 12, Column 1, lines 12-15.) Murphy describes calculating trip distance "as a function of the number of input odometer pulses received … during an elapsed time period." (Ex. 12, Column 4, lines 45-48.) Murphy uses GPS information "for calibrating and cross checking of input odometer pulses." (Ex. 12, Column 5, lines 15-18.)

42. As another example, US Patent No. 4,263,657 to Takashi Oka et al. ("Oka"), issued April 21, 1981, describes typical trip meters, both mechanical and electronic. For the mechanical type of trip meter, "a mechanical counter including a numeral display device is driven via reduction gears by a drive shaft operatively connected to the transmission or other mechanism of the vehicle." (Ex. 10, Column 1, lines 12-16.) For the electronic type of trip meter, Oka explains that "[t]he travelled distance sensing circuit 10 [of an electronic trip meter] includes a pulse signal

generator (not shown) which generates a pulse signal each time the vehicle travels a pre-determined unit distance. The pulse signal generator may be operatively connected to a drive shaft of the transmission (not shown) or to the odometer (not shown) of the vehicle." (Ex. 10, Column 2, lines 62-68.) Both types of trip meter receive an input collected from the taxi itself.

43. As another example, U.S. Patent No. 4,409,685 to Claude F. Ricard ("Ricard") issued October 11, 1983, describes an electronic taximeter. (Ex. 11.) The electronic taximeter includes "a pick-up 6 which is connected to a tachometric cable 7 which is plugged into the output shaft of the speed-box and turns at the same speed as said shaft. The pick-up 6 delivers pulses in number proportional to the number of rotations of the output shaft of the speed-box and therefore to the distance travelled by the taxi." (Ex. 11, Column 6, lines 55-61; *see also*, columns 1-2 discussing the prior art.) This part of the taximeter would be the trip meter.

44. In addition to these patent examples, dictionary definitions also support my understanding of "trip meter" in 1998. For example, in the online Motor Era Automotive Dictionary, the term "trip meter" means "[a]n instrument which measures the distance a vehicle travels from the last time it was reset and runs in conjunction with the odometer." (Ex. 17.) This definition can be found at https://www.motorera.com/dictionary/tr.htm.

45. My understanding is also documented in the *How Taxi Meters Work* article on the HowStuffWorks webpage found at https://auto.howstuffworks.com/taxi-meter.htm. This webpage describes that: "A taxi meter uses electric pulses to measure both distance and time. To get the distance traveled, the meter relies on a sensor attached to the cab's transmission. The sensor sends an electric pulse to the meter every time the cab travels a given distance." (Ex. 9, page 3.)

46. The '727 Patent does not provide any details regarding the trip meter other than it measures actual distance traveled without the use of GPS and map data. A POSITA would

understand that a trip meter is a device in the taxi that determines distance traveled using input collected from the taxi. For example, the input may come directly from the transmission, drive shaft, or odometer of the taxi, but would not use GPS data in 1998. Even though GPS technology existed at the time, it was not used in any trip meters that I knew about at that time.

C. "Starting Point" (Claims 1, 7, and 12)

47. The term "starting point" is found in claims 1, 7, and 12 of the '727 Patent.

48. In claim 1, the term "starting point" is found in two places. First, the term "starting point" is found in the phrase: "a trip meter connected to said computer, said trip meter for measuring an actual trip distance traveled by said taxi between a ***starting point*** and a destination point." Then it is found in the following phrase: "instructions loaded in said computer instructing said computer to calculate an estimated shortest trip distance between said ***starting point*** and said destination point."

49. In claim 7, the term "starting point" is found in two places. First, the term "starting point" is found in the phrase: "determining a ***starting point*** for a trip." Then it is found in the following phrase: "determining an estimated shortest trip distance between said ***starting point*** and said destination point."

50. In claim 12, the term "starting point" is found in three places. First, the term "starting point" is found in the phrase: "determining a ***starting point*** for a trip based on the received geographical location information." Then it is found twice in the following phrase: "determining an estimated shortest trip distance between said ***starting point*** and said destination point based on the street information or on a straight-line distance determined between the ***starting point*** and destination point."

51. The '727 Patent states that "[w]hen a trip is begun at block 21, e.g., when the

taximeter is activated or a specific initiating input is provided to the computer, the geographical starting point is determined at block 22, and the starting time is marked at block 23." (Ex. 1, Column 2, lines 39-43; *see also*, Column 3, lines 27-31.) The '727 Patent does not provide any details regarding how a "taximeter is activated" or how to provide "a specific initiating input" at block 22, highlighted below.

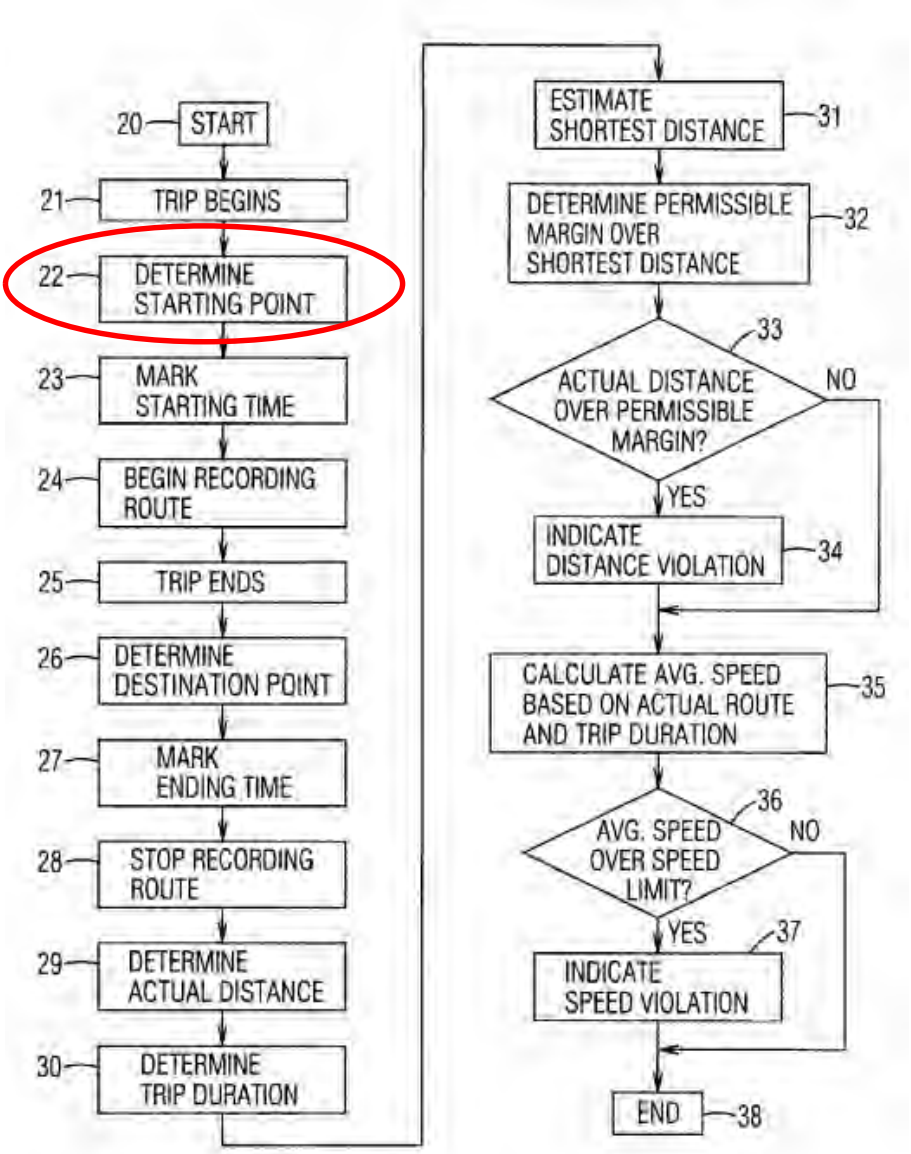


Fig. 2

52. The '727 Patent also describes that "the starting … point[] may be inputted before

the trip to provide advance notice of the fare." (Ex. 1, Column 4, lines 33-35.) The '727 Patent does not describe how this would be done.

53. In my experience, the starting point of a taxi ride is usually when a taxi driver starts the taximeter by dropping the "flag" or pressing a start button on the meter that corresponds to the geographic location where the ride begins. As I describe in my book, the "initial charge for taxi engagement [is] commonly called a 'flag drop' or 'flag fall'" because early taximeters required the taxi driver to physically move a "flag" to start the trip measurements. (Ex. 4, page 123.) As another example, Murphy describes a "start-of-trip" button that a taxi driver uses "to activate operation of the taximeter." (Ex. 12, Column 5, lines 6-9.)

54. A POSITA would understand that the claimed "starting point" is the "geographical location where the ride began."

D. "Destination Point" (Claims 1, 7, and 12)

55. The term "destination point" is found in claims 1, 7, and 12 of the '727 Patent.

56. In claim 1, the term "destination point" is found in two places. First, the term "destination point" is found in the phrase: "a trip meter connected to said computer, said trip meter for measuring an actual trip distance traveled by said taxi between a starting point and a ***destination point***." Then it is found in the following phrase: "instructions loaded in said computer instructing said computer to calculate an estimated shortest trip distance between said starting point and said ***destination point***."

57. In claim 7, the term "destination point" is found in two places. First, the term "destination point" is found in the phrase: "determining a ***destination point*** for said trip." Then it is found in the following phrase: "determining an estimated shortest trip distance between said starting point and said ***destination point***."

58. In claim 12, the term "destination point" is found in three places. First, the term "destination point" is found in the phrase: "determining a ***destination point*** for said trip." Then it is found twice in the following phrase: "determining an estimated shortest trip distance between said starting point and said ***destination point*** based on the street information or on a straight-line distance determined between the starting point and ***destination point***."

59. The '727 Patent states that "[w]hen the vehicle has reached its destination and the trip is ended at block 25, e.g. when the taximeter is deactivated or a specific terminating input is provided to the computer, the geographical destination point is determined at block 26, and the ending time is marked at block 27." (Ex. 1, Column 2, lines 44-49 *see also*, Column 3, lines 32-37.) The '727 Patent does not provide any details regarding how a "taximeter is deactivated" or how to provide "a specific terminating input" at block 27, highlighted below.

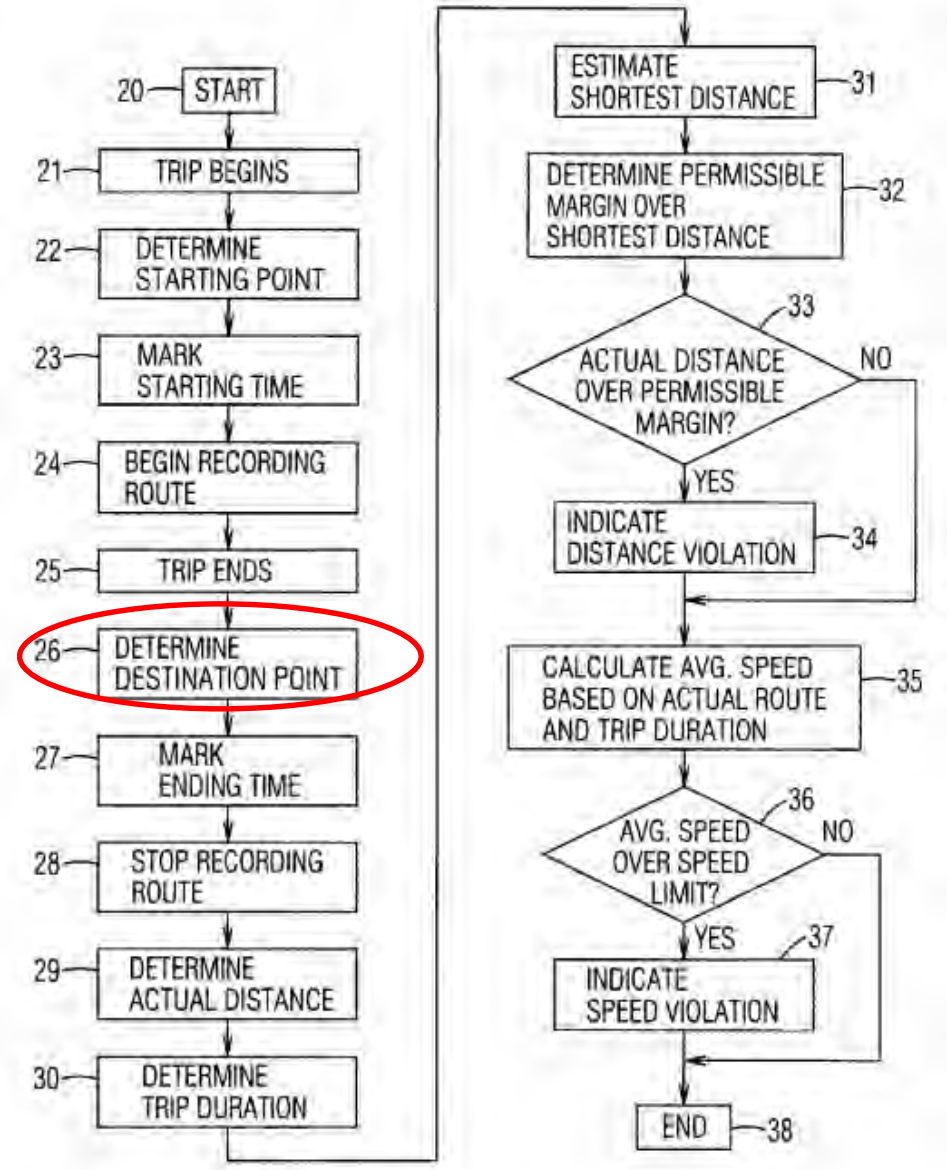


Fig. 2

60. As described with respect to "starting point," the '727 Patent also describes that "the … ending point[] may be inputted before the trip to provide advance notice of the fare." (Ex. 1, Column 4, lines 33-35.) As previously described, the '727 Patent does not describe how this would be done.

61. In my experience, the destination point of a taxi ride is usually when a taxi driver

stops taximeter, by either raising the "flag" or pressing an off button, which corresponds to the geographic location where the ride ends. For example, Murphy describes an "end-of-trip" button that a taxi driver uses to stop the operation of the taximeter. (Ex. 12, Column 5, lines 9-12.)

62. A POSITA would understand that the claimed "destination point" is the "geographical location where the ride ended."

E. "Waiting Time Encountered in Traffic" (Claim 12)

63. The term "waiting time encountered in traffic" is found in claim 12 of the '727 Patent. Specifically, it is found in the phrase "determining an estimated ***waiting time encountered in traffic*** during said trip based on the geographical location information and the street information."

64. According to the '727 Patent, "[a] taxi fare is typically determined by a taximeter based on trip distance and waiting time in traffic." (Ex. 1, Column 1, lines 24-25.) In addition to a distance measuring device, a POSITA understands that a taximeter may have a timing device that measures the amount of time the taxi is stopped or traveling at a reduced speed. This time measure would be applied to the regulated rate tariff for the taxi. The taximeter would then apply either the distance rate or time rate, whichever is greater, or combine and apply both measures in the case of stop and go traffic.

65. For example, below is a table showing taxi fares in New York City from 1952 until 2006. (Ex. 13, The New York City Taxicab Fact Book, Schaller Consulting, March 2006, page 18, Table 2.) As seen in Table 2, in March 1996, a person taking a taxi ride in New York City would be charged an initial charge of $2.00 for the first 1/5 of a mile, then $0.30 per additional unit, where a unit is distance (one unit equals 1/5 mile) and/or wait time (one unit equals 90 seconds). (Ex. 13, pages 16, 18.) "As a cab moves at more than 12 mph, the meter clocks distance.

When a cab is stopped or moving at less than 12 mph, the meter clocks time. This method of calculating fares is uniform throughout the U.S. and conforms to federal standards for taximeters." (Ex. 13, page 16; *see also*, Ex. 14, "Cabs Charge Not Only For Mileage But For The Time Spent At Red Lights," DeseretNews, May 27, 1990, page 2 (describing 9.6 mph as the NYC threshold speed in 1990).)

Table 2. Taxi fares since 1952.

	Initial Charge	Mileage Charge	Wait Time	Charge per Mile	Charge per Minute	Avg. fare
Before 1952	$0.20 first 1/4 mi.	$0.05 per 1/4 mi.	$0.05 per 2 min.	$0.20	$0.03	$0.83
July 1952	$0.25 first 1/5 mi.	$0.05 per 1/5 mi.	$0.05 per 90 sec.	$0.25	$0.03	$1.06
Dec. 1964	$0.35 first 1/5 mi.	$0.05 per 1/5 mi.	$0.05 per 90 sec.	$0.25	$0.03	$1.16
Jan. 1968	$0.45 first 1/6 mi.	$0.10 per 1/3 mi.	$0.10 per 2 min.	$0.30	$0.05	$1.48
March 1971	$0.60 first 1/5 mi.	$0.10 per 1/5 mi.	$0.10 per 72 sec.	$0.50	$0.08	$2.30
Nov. 1974	$0.65 first 1/6 mi.	$0.10 per 1/6 mi.	$0.10 per 60 sec.	$0.60	$0.10	$2.71
March 1977	$0.75 first 1/7 mi.	$0.10 per 1/7 mi.	$0.10 per 60 sec.	$0.70	$0.10	$3.09
July 1979	$0.90 first 1/7 mi.	$0.10 per 1/7 mi.	$0.10 per 60 sec.	$0.70	$0.10	$3.24
April 1980	$1.00 first 1/9 mi.	$0.10 per 1/9 mi.	$0.10 per 45 sec.	$0.90	$0.13	$4.06
July 1984	$1.10 first 1/9 mi.	$0.10 per 1/9 mi.	$0.10 per 45 sec.	$0.90	$0.13	$4.16
May 1987	$1.15 first 1/8 mi.	$0.15 per 1/8 mi.	$0.15 per 60 sec.	$1.20	$0.15	$5.08
Jan. 1990	$1.50 first 1/5 mi.	$0.25 per 1/5 mi.	$0.25 per 75 sec.	$1.25	$0.20	$5.70
March 1996	$2.00 first 1/5 mi.	$0.30 per 1/5 mi.	$0.30 per 90 sec.	$1.50	$0.20	$6.85
May 2004	$2.50 first 1/5 mi.	$0.40 per 1/5 mi.	$0.40 per 120 sec.	$2.00	$0.20	$8.66
Nov. 2006	$2.50 first 1/5 mi.	$0.40 per 1/5 mi.	$0.40 per 60 sec.	$2.00	$0.40	$9.61

Surcharges and flat fares:

- A night surcharge, applying to trips beginning between 8 p.m. and 6 a.m., was added in May 1981. The surcharge was rescinded in January 1982 for all but the 2,300 fleet cabs. The 50-cent night surcharge was extended to the entire industry in May 1987.
- $1 surcharge for trips beginning between 4 p.m. and 8 p.m. was added in May 2004.
- A $30 flat fare from JFK airport to Manhattan was adopted in January 1996 and increased to $35 in 2001 and $45 in 2004. The flat fare was extended to trips from Manhattan to JFK airport in 2006.
- Surcharge for trips to Newark Airport was increased from $10 to $15 in 2004.

Average fare based on 2.8 mile trip with 4.77 minutes of wait time.

66. As described in Specification S.1.4. of the NIST Handbook on Taximeters, "the fare-indicating mechanism shall be actuated by the distance mechanism whenever the vehicle is in motion at such a speed that the rate of distance revenue equals or exceeds the time rate, and may

be actuated by the time mechanism whenever the vehicle speed is less than this and when the vehicle is not in motion." (Ex. 18, page 5-27.) This handbook also includes Specification S.2 shown as follows.

S.2. Basis of Fare Calculations. – A taximeter shall calculate fares only upon the basis of

(a) distance traveled;

(b) time elapsed; or

(c) a combination of distance traveled and time elapsed.

(Amended 1977)

(Ex. 18, page 5-29.)

67. A POSITA would understand that wait time is applied in two situations. First, wait time is applied when the taxi was stopped or below a speed threshold (e.g., in stop and go traffic). A second context for wait time would be the time a taxi driver needed to wait for a person who is not ready to start the trip or wait when the passenger asks to stop for a reason, such as stopping at the store.

68. The term, however, is "waiting time ***encountered in traffic***." It is not clear if this is the same "waiting time" known by a POSITA for calculating a taxi fare.

69. The '727 Patent also states that "[a]n estimated waiting time in traffic along the optimal route is determined at block 51 based on location traffic information and the time of day to account for traffic lights, traffic congestion, etc." (Ex. 1, Column 3, lines 51-54.) The '727 Patent shows that this estimation occurs after a trip is ended as shown in Figure 3 below, highlighting block 51.

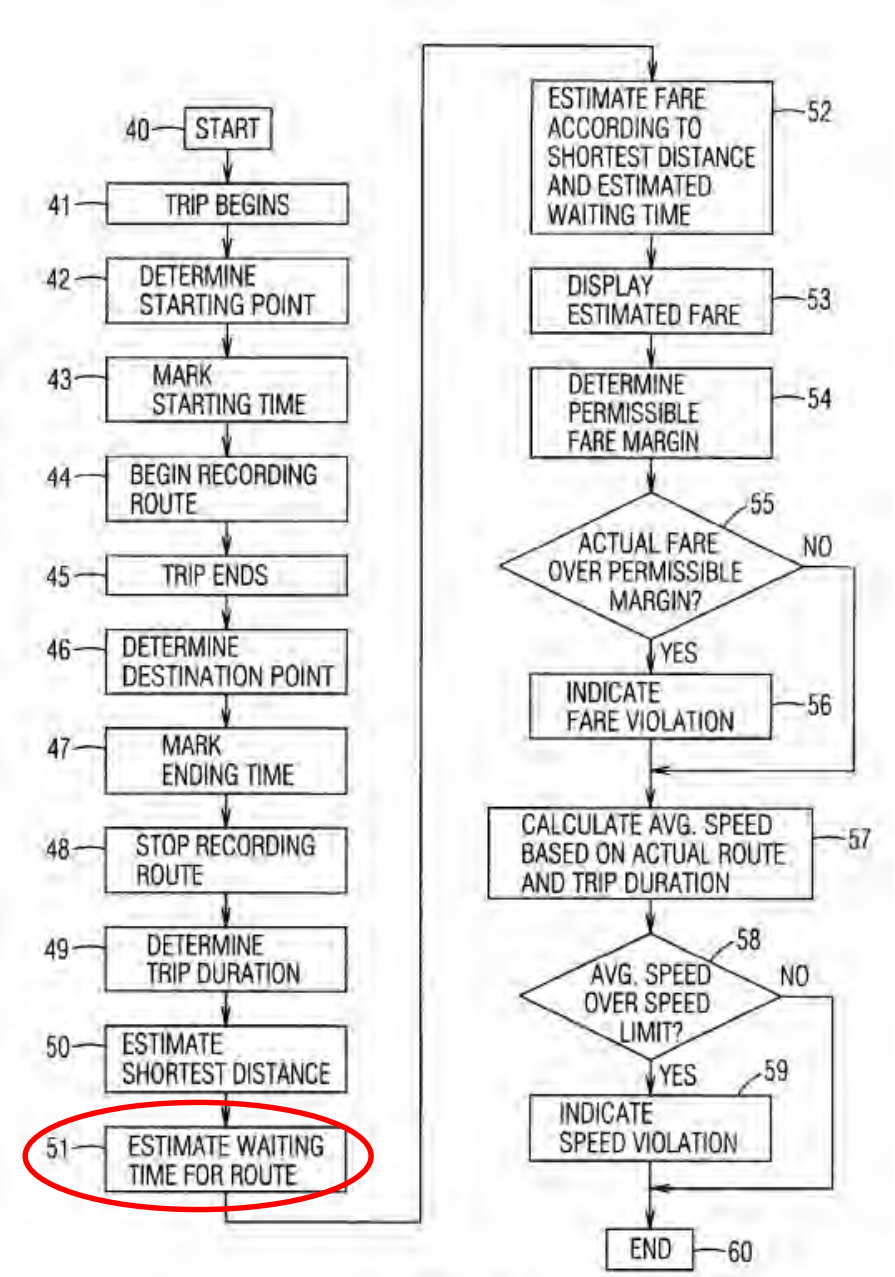


Fig. 3

70. The '727 Patent does not provide an algorithm or other explanation regarding how the waiting time is estimated. As described above, some taxis may charge the waiting time rate when stopped or below a predefined speed threshold. (Ex. 13, The New York City Taxicab Fact Book, Schaller Consulting, March 2006, page 16; Ex. 14, "Cabs Charge Not Only For Mileage But For The Time Spent At Red Lights," DeseretNews, May 27, 1990, pages 1-2 ("Once the cab

is stopped, riders are charged by the second and not by the mile." … "Any speed under 9.6 mph starts the waiting time rate.").)

71. Other taxis may switch between the distance rate and time rate, applying the highest of the two calculations. For example, Ricard describes "that the taxi fare which is displayed by a taximeter is obtained by continually comparing the rate per kilometer with a rate per hour and by applying every time the highest of the two." (Ex. 11, Column 1, lines 9-12.) "For each portion of a taxi run, the calculating unit sets up the partial fare by multiplying either the distance travelled by the set price of the unit of distance, or the time spent by the set price of the unit time." (Ex. 11, Column 1, lines 27-31.)

72. A POSITA reading the '727 Patent would not have a clear understanding of the scope of the phrase "waiting time encountered in traffic" as the term "waiting time" typically was not limited to time in traffic, but the entirety of the slow or non-driving time for a trip. I cannot understand the meaning ascribed to "waiting time in traffic" by the '727 Patent, as it could be the time listed on a rate card, the time actually stopped in traffic, the time stopped at a light, and/or the additional time it takes to travel a route due to rush hour conditions, an accident, and/or bad weather as compared to the time of travel with perfect conditions. In addition, the '727 Patent does not explain what qualifies as "traffic" – traffic could refer to mild congestion, a complete traffic stoppage, or anything in between.

73. To the extent a POSITA would understand the phrase "waiting time encountered in traffic" in 1998, it would be consistent with the ordinary meaning of "waiting time" in the industry, namely the "amount of time spent stopped or below a predefined speed threshold," which is the meaning that a POSITA would ascribe to the term "waiting time" in 1998.

VII. ADDITIONAL REMARKS

74. I currently hold the opinions expressed in this Declaration. But my analysis may continue, and I may acquire additional information and/or attain supplemental insights that may result in added observations.

75. I reserve the right to respond to any additional arguments or opinions raised by Plaintiff or Plaintiff's expert(s). I further reserve the right to respond to any new positions raised by Plaintiff or respond to any further expert declaration provided by Plaintiff regarding claim construction issues.

* * *

I hereby declare that all statements made are of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code and that such willful false statements may jeopardize the validity of this proceeding.



Dated: Oct. 5, 2022_____ By: _____

Dr. Ray A. Mundy, D.Sc.
Columbus, Ohio

Exhibit A

COMPREHENSIVE VITA

Ray A. Mundy, Ph. D
Transportation Professor Emeritus
University of Tennessee, Knoxville
314-225-7039

I. EDUCATIONAL BACKGROUND

1973	Ph.D. in Transportation and Logistics, Pennsylvania State University Minor: Marketing, Management, Social Psychology Dissertation: "U.S. and Canadian Urban Mass Transportation Systems: A Comparative Empirical Analysis"
1967	M.B.A. in Management, Bowling Green State University Minor: Statistics
1966	B.A. in General Business, Bowling Green State University

ACADEMIC EXPERIENCE

2000 – 2019	Barriger Endowed Professor of Logistics & Transportation and Director, Center for Transportation Studies, University of Missouri-St. Louis
1996 - 2000	Taylor Distinguished Professor of Logistics and Transportation, The University of Tennessee, Knoxville
1982 – 1996	Professor, The University of Tennessee
1977 – 1982	Associate Professor. The University of Tennessee
1973 – 1977	Assistant Professor of Marketing and Transportation, The University of Tennessee
1970 – 1973	Research Assistant, Pennsylvania State University
	Graduate Assistant, Department of Transportation and Logistics, Pennsylvania State University
	Teaching Assistant, Department of Management, Pennsylvania State University

1969 - 1970	Faculty Member, Department of Business Administration, Lycoming College *Taught senior-level courses in Management, Organizational Theory, Business Policies, and supervised local undergraduate research efforts.*
1968 - 1969	Faculty Member, Department of Management, Eastern Michigan University *Taught courses in Principles of Management and Personnel Management.*
1967 - 1968	University Faculty Member, Department of Management, Bowling Green State *Coordinated and taught Master Lecture in Introduction to Business, Master Lecture size of approximately 300 students per semester. Supervised the teaching of five graduate students. Taught senior level courses in Problems of Production and Personnel, and Marketing.*
1966 - 1967	Graduate Teaching Assistant, Bowling Green State University

II. INSTRUCTIONAL RESPONSIBILITIES

A. COURSES TAUGHT

Dr. Mundy has gained considerable teaching experience from his association with several universities. He was a faculty member at Bowling Green State University, Eastern Michigan University, Lycoming College and Pennsylvania State University and the faculty at The University of Tennessee before joining the University of Missouri at St. Louis as Barriger Endowed Professor of Transportation and Logistics, Founder and Director of the Center for Transportation Studies.

Teaching responsibilities at The University Missouri-St. Louis included the following areas:

- Domestic Transportation
- Supply Chain Management

The above courses have been taught at both graduate and undergraduate levels.

Other courses taught:

- Executive in Residence
- Introduction to Business
- Introduction to Logistics
- Introduction to Transportation
- Management

- Marketing
- National Transportation Policy
- Organizational Development
- Organizational Theory
- Personnel
- Process Management
- Production
- Statistics
- Traffic Management
- Urban Transportation

Outside the university, Dr. Mundy has developed a number of Executive Development courses for individual firms and industries. These courses have been taught multiple times and would include text length treatment of such topics as:

- Work Process Flow
- Continuous Improvement
- Statistical Process Control
- Transportation Management
- Supply Chain Management

B. COURSE DEVELOPMENT AND TEACHING CREATIVITY

In nearly 50 years of university teaching, Dr. Mundy has prepared numerous courses and participated in many course revisions. Over the years, he has developed an Introduction to Logistics & Transportation graduate course; an Integrated Supply Chain graduate course; and a Supply Chain Software "Tools" graduate course. A research paper describing this last course received the "Plowman Award" for the discipline's outstanding paper of 1997.

C. INDEPENDENT STUDIES, DISSERTATION AND THESIS DIRECTION

1. INDEPENDENT STUDIES

Supervised approximately 65 independent study projects concerning all aspects of Transportation and Logistics beginning in 1974 and continuing to the present day. These independent student projects were at the undergraduate, masters, and Ph.D. levels.

2. Ph.D DISSERTATION AND THESIS DIRECTION

2014 North, Jeremy. *Network Flexibility for Recourse Considerations in Bi-Criteria Facility Location*

2014 Boyce, Wesly. *Supply Chain Relationships: Is Collaboration Reality?*

1999 Pappau, Madhav. *The Three Faces of Inter-Organizational Relationships: Toward a Theory of Logistics Relationships, Strategy, and Inter-Organizational Learning*

1998 Whitaker, Jonathan. *Contracts for Logistics Transportation Services: Comparing Contract Content Strategic Positioning*

1997 Kellar, Gregory. *Cost Allocation Pricing (Cap) In the Motor Carrier Industry*

1995 Gibson, Brian. *Utilization and Value In the Purchase of Industrial Transportation Services*

1984 Gourdin, Kent Neill. *An Analysis of National Aviation Policy With Respect to America's Strategic Airlift Capability*

D. TEACHING HONORS, GRANTS AND AWARDS

2000 – 2019 Barriger Endowed Professor of Transportation and Logistics

1999 - 2001 John Deere Senior Research Fellow

1996 – 1999 Taylor Distinguished Professor

1995 – 1996 University of Tennessee, Knoxville College of Business Regan Faculty Scholar

E. CONTINUING EDUCATION

1996 - 1998 Taiwan MBA Program (two week seminar in Work Process Management)

III. RESEARCH

A. INDUSTRY RESEARCH PROJECTS directed and authored by Dr. Mundy. Available from cities, airports, and entities noted.

- **Seattle, Washington (2013) City/County Taxi Demand Study**
- **Houston, Texas (2013) City Taxi Study**
- **Austin, Texas (2012) City Taxi Study**
- **San Antonio, Texas, (2011) City Taxi Study**
- **Saskatoon, Saskatchewan, Canada (2010) City Taxi Study**
- **Regina, Saskatchewan, Canada (2010)**

- **Winnipeg, Manitoba, Canada (2009) City Taxi Study**
- **Anaheim, Calf. (2009) – City Taxi Study**
- **San Diego, California – Expert Witness, Taxi Driver Classification**
- **Winnipeg, Canada (2009) – City Taxi Study**
- **LAX Taxi Dispatch System (2008)**
- **Denver, Colorado (2008) – City Taxi Study**
- **Anchorage, Alaska (2008) – City Referendum on Taxi Deregulation Study**
- **Coachella Valley (Palm Springs) (2007) – Area Wide Taxi Study**
- **City of Hampton, Va. (2007) - City Taxi Study**
- **Salt Lake City (2005 - 2009) - City Taxi Study**
- **Miami-Dade County Taxi Study (2006) - City Taxi Study**
- **San Francisco Int'l Airport (2006) – Analysis of Airport Taxi Incentives**
- **Ft. Meyers – Exclusive Airport Taxi Concession (2006)**
- **Hillsborough County – Expert Witness, Taxi/Limo Suit (2005)**
- **Taxi Seminar Series – TLPA 2004 - 2005 – Developer & Director**
    - **Maintenance**
    - **Marketing**
    - **Technology**
- **City of Dallas (2003) - City Taxi Study**
- **Indianapolis Airport (2003) – Analysis of Taxi Operations**
- **Raleigh/Durham Airport (2002) – Analysis of Taxi Operations**
- **City of Orlando (2001) - City Taxi Study**
- **DFW Airport (2000) – Analysis of Curb Placement for Taxis**
- **City of Portland, Maine (1999)- Airport Taxi Analysis**
- **MSP Airport (1999) – Airport Taxi Analysis**

B. REFEREED ARTICLES & PUBLISHED RESEARCH REPORTS, PRESENTATIONS

"Using History to Develop Future Regulation of TNCs and Autonomous Taxis" **Mundy, Ray, A.,** Public Private Partnerships and Deregulation in Transportation, with Springer Science, Publisher. Book Chapter forthcoming 2021

"Women in North American Railroad Operational Roles: Opportunities and Challenges" Rust, Daniel; **Mundy, Ray A,** Research in Transportation Economics, Volume 84, December 2020, 100917

"The airport ground transportation industry during COVID-19" **Ray A. Mundy,** *Executive Director, Airport Ground Transportation,* Journal of Airport Management, November, 2020

"Cost Benefit Analysis: Substituting the Subsidized Essential Air Services with a Subsidized Ground Transportation Service" Ken Bao, Abby Wood, **Ray A. Mundy**, MTC Report, 2016

Readings in Modern Railroad Management, Volumes One, Two, and Three, **Ray A. Mundy** and Daniel Rust, (2014) Bookpatch Publishing, 762 pages.

"Airport Drop-Off Charges in Great Britain: Will they come to the United States? Emma J. Nix, **Ray A. Mundy**, MTC Report, 2016

Taxi! Urban Economies and the Social and Transport Impacts of the Taxicab. James Cooper, **Ray Mundy** and John Nelson (2010) Ashgate Publishing, 208 pages.

Mundy, Ray, (April, 2016), "Trends in the Airport Ground Transportation Industry – Implications for the Taxi Industry" presented at the Australian Taxi Association's Annual Meeting, Gold Coast, Queensland, Australia

Mundy, Ray, (April, 2016), "Impact of TNCs on Airports" presented at the AGTA Spring AGTA Conference, Los Angeles, California

"St. Louis Metropolitan Taxi Commission Report on Regulation" **Ray A. Mundy**, Midwest Transportation Consortium, Iowa State University, DOT Report, 2015.

"Mass Transit Sustainability on the St. Louis Region", **Ray A. Mundy**, Daniel L. Rust, Sareema Koirala Phillips, Sidra Naseer, Maria Gabriela Rodriguez Paez, Elizabeth Snowden, MTC Report, 2015

Mundy, Ray, (September, 2015), "Should Airports Set Maximum Rates for TNCs?" presented at the AGTA Fall Conference, Minneapolis, Minnesota

Mundy, Ray, (April, 2015), "Should Private Vehicles Pay for the Use of Airport Curbs?" presented at the AGTA Spring Conference, Miami, Florida

Mundy, Ray, (September, 2014), "Does TNC Control Make Their Drivers Employees?" presented at the AGTA Fall Conference, Phoenix, Arizona

Mundy, Ray, (April, 2014), "How Should Airports React to TNCs?" presented at the AGTA Spring Conference, Clearwater, Florida

Mundy, Ray, (April, 2013), "Can Small Airports Support Shared Ride Van Service?" presented at the AGTA Fall Conference, St. Louis, Missouri

Bao, Ken; Wood, Abby, and **Ray Mundy** (2015) "Cost-Benefit Analysis: Substituting Ground Transportation for Subsidized Essential Air Services" U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology 1200 New Jersey Avenue, SE, Washington, D.C.

Nix, Emma and **Ray Mundy** (2015) "Airport Drop-Off and Pick-Up Charges in Great Britain: Will They Come to the United States?" U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology 1200 New Jersey Avenue, SE, Washington, D.C.

Nix, Emma and **Ray Mundy** (2015) "Economic Benefits of Additional Rail Bridge Capacity: A Case Study on the Benefits of Replacing the Merchants Bridge Main Spans at Saint Louis" U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology 1200 New Jersey Avenue, SE, Washington, D.C.

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B.1 WORK IN REVIEW AND DEVELOPMENT

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D. APPLIED SCHOLARSHIP AND NONREFERRED ARTICLES

1. APPLIED SCHOLARSHIP

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Rutner, Stephen M., and Ray Mundy (1996), "Hubs vs. Hub-Nots: A comparison of Various U.S. Airports." Journal of Air Transportation World Wide, Vol. 1, pp. 81-90. [50%]

Gibson, Brian, Ray A. Mundy, Stephen M. Rutner, and Harry Sink (1995), "Transportation Purchasing Strategy: A Survey of U.S. Industrial Shippers." Reprint of previous article for the American Society of Transportation and Logistics, Inc., Transportation Systems Review Guide. [25%]

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I. BOOK CHAPTERS, BOOK REVIEWS, PROCEEDINGS, ABSTRACTS AND OTHER WORK

1. BOOK CHAPTERS

Mundy, Ray and Frank. W. Davis, Jr., George Gray, and Lester Hoel, Ed. (1978), "Public Transportation Marketing." Chapter 22, Urban Transportation Management, Englewood Cliffs, New Jersey: Prentice-Hall, Inc.

2. BOOK REVIEW

Running on Empty by Lester R. Brown, Christopher Flavin, and Colin Norman. In Journal of Consumer Affairs, p. 86, Spring 1981.

3. REFEREED PROCEEDINGS

Mundy, Ray, Campbell, James, Smith, L. Douglas, (April, 2006) "Modeling Net Charges for Expedited Freight Services," presented at Precision Services Institute, Hawaii (pp: 558-560)

Whitaker, Jonathan, and Ray Mundy (1999), The Material Elements of the Logistics "2000 and Beyond" Contract. Proceedings of the Council of Logistics Educator's Conference, Toronto, Ontario, Canada. [50%]

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Mundy, Ray and Brian J. Gibson (1995), "Developing an Effective Logistics Benchmarking Program." Proceedings of the Council of Logistics Management Annual Conference, Oak Brook, Illinois. [50%]

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Mundy, Ray (1974), "Internal Organization and Decision Making of Urban Transit Systems." Proceedings of the 1974 American Institute of Decision Sciences Meeting, Atlanta, Georgia. [100%]

J. RESEARCH HONORS, GRANTS, AWARDS

As Associate Director of The University of Tennessee's Transportation Research Center (1976-81) Dr. Mundy directed several major research projects including a detailed study of 42 transit properties in the U.S. and Canada, an analysis of training programs needed in the transit industry, and an analysis of the marketing management practices within the U.S. transit industry. Dr. Mundy was a major investigator on the $1,000,000 UMTA demonstration project entitled "Implementation of a Public Transportation Brokerage Service Serving Knoxville, Tennessee." Projects directed by Dr. Mundy include the $500,000 National Cooperative Highway Research Project 8-16 "Guidelines for Public Transportation Levels of Service and Evaluation," the $300,000 Urban Mass Transportation's nationwide training program entitled, "Dissemination of the Brokerage

Concept," and the $l30,000 Department of Transportation's University Research project utilizing non-print media to aid decision makers in planning urban transportation. Dr. Mundy has directed the public service activities of the Tennessee Transportation Brokerage Program, the Knoxville Commuter Pool, the Knoxville Area Vanpooler's Association, and the Knoxville Service and Fare Demonstration Project. His research and technical assistance projects were funded at an annual rate of between $300,000 and $500,000.

While at the University of Tennessee, Dr. Mundy has also directed and participated in research efforts in a number of related research areas. Such studies include an analysis of the management of interdisciplinary research programs in U.S. universities, funded by the National Science Foundation; warehousing for country-wide applications; private trucking fleet ownership and common carrier pricing strategy analysis; commuter express bus services; and an analysis of the management manpower, operations and marketing activities of all publicly owned transit systems in the State of Tennessee. More recently Dr. Mundy has completed a number of research projects in the Airport Ground Transportation Industry. Such efforts included detailed analysis of operations at the New Orleans, New York, Portland, Indianapolis, Kansas City, San Antonio, Detroit, and Honolulu airports. More recently his research and industry management development programs involve the determination of quality tools and their application in the U.S. rail and motor carrier industry. Toward this end he has developed several executive-training programs for the industry. Current research involves the study of Transportation Vendor Certification programs and analysis of continuous improvement activities within supply chains. Several Ph.D. dissertations have already been developed from this work.

IV. SERVICE ACTIVITIES

A. PROFESSIONAL OFFICES HELD

- Chairman (1982), Transportation Research Board's Committee on Intercity Bus Transportation
- Chairman (1980), Transportation Research Board's Subcommittee on Labor
- Examiner (1976-78), American Society of Traffic and Transportation

B. CONFERENCE RESPONSIBILITIES

- Chairman (1996), Air Cargo Intermodal Conference, Boston, Massachusetts
- Chairman (1977 - Present), Bi-Annual Meetings of Airport Ground Transportation Association

C. INVITED ACTIVITIES

- Editor, Special Edition of International Transportation Planning and Technology Journal – dedicated to private/public transportation
- Distinguished Marketing Professor (Summer, 1983), University of Auckland, New Zealand.

D. REFEREEING

- International Journal of Transportation Planning and Technology
- Journal of Transportation Management

E. EDITORIAL RESPONSIBILITIES

Editor (1977-Present), Airport Ground Transportation News, "Insights" Editor, published monthly by the Airport Ground Transportation Association, [circulation: 500]

Editor (1977-Present), Airport Ground Transportation News, "Curbs" published by the Airport Ground Transportation Association, [circulation: 500]

F. CAMPUS/SYSTEM SERVICE While at UTK and UMSL

Dr. Mundy has served on a variety of committees at the university, college and department levels. At the university level he served on a Campus Transportation Committee, headed by the Vice Chancellor of Business and Finance, and was Chairman of the Search Committee for a new Director of The University of Tennessee Transportation Center. Dr. Mundy has been a member of the University of Tennessee's Faculty Senate and served on the Faculty Senate Executive Committee. He was chairman of the University Faculty Affairs Committee for five years. In this capacity he has participated in the development of a formal grievance procedure for university faculty.

G. SCHOOL OF BUSINESS SERVICE

Within the College of Business Administration, he has served on the Teaching and Learning Improvement Committee and the Graduate Policies Committee. He has served as the departmental representative to the library, the College Management Development program, and the Center of Business and Economic Research. At the department level, Dr. Mundy is currently directing the Executive-In-Residence Program, which he initiated and is the L & T MBA advisor. Upon returning to the faculty, Dr. Mundy revamped the L & T MBA program, which at the time consisted of only one student. Today, the program has grown to graduate between 35 and 40 students annually. Practitioners now rank the Logistics program at the University of Tennessee among the leading academic programs in North America.

Since coming to the University of Missouri – St. Louis, he has developed the Universities' Center for Transportations Studies to support graduate level of research in the transportation field. From 2000 to 2019, over 65 graduate research assistants were support by his Center. His current research interests and research include the enhancement of airport ground transportation operations, the practice of continuous improvement within private transportation firms, intermodal transportation, motor carrier autonomous vehicles, and the local regulation of ground transportation firms. Since inception of the Center for Transportation Studies, Dr. Mundy has generated in excess of $ 2,000,000 in grants.

H. SERVICE HONORS, GRANTS, AWARDS

- Senior Research Fellow, John Deere, Inc., 1999
- U.S. Department of Transportation's Service Award, 1996
- School of Business, Reagan Scholar Award, 1994-1996
- Taylor Distinguished Professorship, 1996

I. COMMUNITY SERVICE

- President, University Faculty Swim Club, 1994

J. CONSULTING

Dr. Mundy, working as a consultant, has performed numerous transportation research projects. Dr. Mundy has been active in the role of a general consultant to several private and public transportation firms, the Federal Government, states and municipal governments. Dr. Mundy has lectured in the Department of Energy's Federal Ridesharing Training Program and directed the development of offices set up to develop and administer ridesharing programs. Past projects have involved consultations with the Federal Department of Energy, the City of Richmond, Virginia, the World Bank, the International City Managers Association, the New York Port Authority, the Economic Opportunity Alliance of Atlanta, George, the Irregular Route Motor Carrier Conference, and the numerous US Airports.

Dr. Mundy has developed and administered a series of 1, 2, and 4-day quality seminars offered to Transportation and Logistics firms. Recent courses have been offered to firms such as Burlington Northern Railroad, Norfolk Southern, CSX, Sea Land, Burlington Motor Carriers, Arkansas Freightways, American Association of Railroad, the American Short Lines Railroad Association, Ryder Integrated Logistics, and TNT.

Dr. Mundy maintains an active lecture/participant role at regional and national transportation meetings. Speaking engagements include keynote presentations at the National Association of Transportation Regulators Annual Meeting (Strasberg, France), presentations at the Transportation Research Forum (TRF) meetings (Washington, D.C.), Council of Logistics Management Transportation and Logistics Educators Conference (Washington, D.C.), International Association of Rail Freight Claims and Adjusters Meeting (Seattle), American Shortline Railroad Association Annual Meeting (Washington, D.C.), the North American Airport Council International Annual Meeting (Orlando, Florida), the Australian Taxicab Association (Hobart, Tasmanian), and the IV International Conference Modern Taxi Novosibirsk, Russia.

K. LEGAL TESTIMONY 2018 TO PRESENT

Francisco Gonzales v. San Gabriel Transit, Inc., Case No. BC536584, California Superior Court, Los Angeles County, prepared declarations on behalf of defendants

Exhibit 4

Taxi!
Urban economies and the social & transport impacts of the taxicab

James M. Cooper, PhD
Ray Mundy, PhD and
John D. Nelson, PhD

Acknowledgements

The authors wish to acknowledge the significant and untiring support of the taxi trade, regulators and licensing officers in the development of this book. Significant thanks are also due to the kind assistance of our university offices and administrators in the preparation of the text and the countless numbers of drivers and operators who contributed through their open and honest commentaries.

We would like also to thank the individual efforts of Sandra Mundy and Ursula Cooper in ensuring that our efforts made sense.

A final word of thanks is owed to the professional and expert guidance of the taxi profession across all our research, especially to the Commissioner of Taxi Regulation, Kathleen Doyle, and her officers; and to Mr. Bill McIntosh of the Scottish Taxi Federation.

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Forward: Taxi! The analysis of an important but neglected mode of urban transport

The taxi plays a significant role in the delivery of transportation in all parts of the world, offering an instantly recognizable consistent service. The mode contributes significantly to the economy of a location providing access to and from social activities, contributing to tourism, and providing socially desirable accessibility to individuals without cars and in use in emergencies. The taxi is often the largest employer in an urban community and will touch the lives of a significant proportion of a city population.

Despite the apparent uniformity of the mode, the taxicab differs from location to location, varying in the types of vehicle used and, most particularly, in the forms of regulation applied to the mode. The former issue, vehicles used as taxis, draws on a fascinating history of taxi development, set out in Chapter one, and is guided by the technologies available, see Chapter six; the latter, regulation and its impact on the provision of taxis is considered, historically in chapter one, and in detail in Chapter two. It is also noticeable that the mode differs from other forms of public transportation both in relative control, positioning within authorities, and in relation to its limited analysis in academic literature, this despite the long-standing and consistent nature of the

mode. The taxicab is the oldest form of licensed public transportation in the world, with the first licensing of taxis traceable to the Seventeenth century.

This book describes the historical development of the taxicab from the earliest regulations some of which, such as the UK 1847 Town Police Clauses Act, remain in force to this day. The book traces the development of controls arising in Europe and the USA, through rapid expansion in taxicabs and taxicab regulation in the USA following the 1920 depression, to current conflict arising between authorities choosing to control taxicabs, and those wishing to deregulate.

Chapter two considers the requirements for taxi regulation, and the arguments used both in its defense and in seeking to move toward a form of deregulated or liberalized market form. The chapter draws on experiences in the UK, in the USA and globally to explain why some authorities have chosen one form of control over another, and touches on the very fierce debates that deregulation sometimes create.

Chapters three and four introduce and detail analytical tools, sometimes called taxi models, used in determining optimal forms of supply including those applied in the UK arising from current legislative requirements in the determination of regulatory structures, and those applied in US cities in delivering optimal taxi structures.

Chapter five, technologies, details the development and significance of changing technologies in the delivery of taxi services. The chapter provides an insight into the current roles played by vehicles, location and booking technologies; as well as discussing the role of vehicle type in uses made of taxis and the ability of the taxicab to meet the needs of the communities it serves. Chapter six considers the special role of the taxi in urban night time economies in providing public transportation as a mode of choice for traveling home from entertainment, and the associated issues of significantly increased levels of demand, heightened awareness of security and safety amongst both passengers and drivers, and related issues of safety at stance (US: cabstand).

Chapter seven continues to look at the specialist roles for taxicabs, considering the role the mode plays in transportation from airports, the issues of supply and controls applied at airports as a part of city controls and separately applied by airport authorities to ensure appropriate supply and, in some instances, as a finance raising measure.

Chapter eight looks at the developing use of taxis within and parallel to other forms of Demand Responsive Transportation, addressing particular transport needs not well served by more traditional modes or existing operating patterns. Chapter nine further continues by looking at the significance of taxis in specialist use, including the use of the mode away from major urban centers to serve remote and reduced populations, and variations of use to deliver transport to employment, travel to hospital and community specialist journeys. The chapter considers the taxicab in a developmental role and extends analysis

to identify the potential of the mode in developing countries including cross-over roles between developing and developed economies. Chapter eleven identifies specific barriers to achieving a maximum benefit from the mode, how historical barriers have existed and continue to prevent full utilization of the mode.

In our final chapter, chapter eleven, we consider the future for the taxi in the provision of transport. We chart the major opportunities in the use of taxis. We outline the potential for innovation within the mode, and the opportunities arising from a mainstream conscience and acceptance of the mode.

Chapter One: Historical development of the taxi

Introduction

The taxicab, in various incarnations, remains one of the oldest licensed and most recognizable forms of public transport still in use today. This is not to say that other forms of transport have not existed in parallel with the taxi, but rather that the history of the taxi is significant and impacts on our current understandings of the mode and its operation.

1.1 Historical Development

The modern taxi owes its design and the nature of current operations to its significant history. There is no doubt that the concept of a shared vehicle operated for reward has been in existence from the very earliest origins of vehicles themselves. The distinct emergence of a taxi is traceable to vehicles for hire in Paris from about 1640[1]. The first recognizable taxi service in the UK can also be traced to the seventeenth century, and is exampled in the 1654 Ordnance for the Regulation of Hackney Coachmen, a regulation designed to

[1] The first Paris Taxis (Voitures a louage) have been attributed to operations initiated by Nicolas Sauvage: See: http://www.herodote.net/histoire/evenement.php?jour=18260810

ensure a level of service in the provision of horse drawn taxis. The 1654 ordnance predates motorized transport and relates to "Hackney Carriages", named after the French word "Haquenée" a cart pulling horse[2]. The term Hackney Carriage (Hack, Black Hack) has stuck and remains in use today together with the more common term "taxi" which is suggested to originate from the German "Taxemeter" – literally the meter designed to measure tax (fare), invented in 1891 by Wilhelm Bruhn.

Although the term "taxi" can be applied to across the entire gambit of vehicle types, further distinctions exist. The most common of which is between Hackney Carriages – itself a legal definition of a vehicle available for hire on street; and Private Hire Vehicles (PHVs), vehicles restricted to pre-booked (dispatch) journeys. Hackney and PHV taxis represent the majority of all "taxi" journeys, the existence of both forms of taxi within a single authority area often being referred to as a "dual system" of supply. Some variation of these terms exists, with the US referring to pre-booked vehicles as "livery taxis" named after the livery or appearance of the vehicle, while in Ireland, and somewhat confusingly, the term "Hackney" is applied to PHVs. The diminutive term "Hacks" is widely applied particularly in the trade and can refer to most forms of taxi dependant on local precedent, see Table 1.1, below.

[2] http://onlinedictionary.datasegment.com/word/hackney

Table 1.1 Taxonomy of names used to describe taxis:

Description	UK Terms used	US Terms used	Wider terms used (by country)
Vehicle for Hire and Reward. Available for engagement on street	Hackney Carriage* (Hackney / Hack) (Street Taxi) (Black Taxi – Not Northern Ireland) (Public Hire Taxi – Northern Ireland) (Small Public Service Vehicle)	Taxi (Cruising Taxi)	Taxi Small Public Service Vehicles* (Republic of Ireland)
Vehicle for Hire and Reward. Available by pre-booking only or available from depot	Private Hire Vehicle* (PHV) (Minicab) (Taxicab) (Private Hire Taxi – Northern Ireland)	For Hire Vehicle (FHV) (Livery Vehicle) (Dispatch Vehicle) (Car Service) (Black Car)	Hackney (Republic of Ireland)
Small Vehicle used for multiple occupancy taxi journeys	Taxibus (DRT Taxi) (Black Taxi – Northern Ireland)	Shuttle	Jitney (Camioneta) (Shared Taxi) (Sammel Taxi) (Bush Taxi)
Specialist vehicle used in exclusive hire	Limousine	Limousine	

Note: * - denotes legal definition
Source: Adapted from Coper, 2007; Schaller 2002

The two further forms of taxi operation, Taxibus and Limousine, are less widespread than their dual system counterparts, but play a significant role in distinct market segments. Taxibuses in particular have emerged as a recent development in Western locations and owe much of their history to a lack of more formalized transport. The taxibus is typified by Jitney operations in developing countries, shared Camionetas amongst immigrant populations in the USA, and "Black Taxi" shared buses in some UK cities.

Schaller (2002) provides a good description of distinctions within the US "For Hire Vehicle" market, with specific reference to New York, including a description of car service vehicles, which are formally defined in the USA within the FHV market, but vary distinctly within the group.

While some differences in terminology are common and understandable, the general purpose of the taxi remains consistent. The taxi offers, across a number of forms, personal carriage for an individual or small group for hire and reward. This pattern is repeated worldwide and continues to date following remarkably similar patterns regardless of location.

1.2 From Horses to motorized vehicles

In the period from the early Seventeenth Century to the end of the Nineteenth, the horse drawn Hackney Carriage became a recognized part of city life in many parts of the world. Horse drawn vehicles of varying designs can be seen in historical accounts in most cities with a significant advance in design coming with the Hansom Cab, a horse drawn carriage patented in 1834 by Joseph Hansom, originally built in Leicestershire and adopted widely in London.

The Hansom cab differed in design from previous horse drawn carriages in that the vehicle ran on two wheels connected by a single horizontal axle, with the driver seated above and viewing over the passenger seat. The vehicle was

light and thus quick in comparison to earlier carriages, and offered a degree of maneuverability not possible in the more rigid twin axle carriages it replaced. The design was popular in many cities including those in America, the Hansom Cab Company, founded in 1869, offering similar vehicles in New York. Irish and Scottish versions included the "Noddy", a small two wheeled carriage slung behind a single horse.

The first motorized taxis appeared from 1890, initially as electric vehicles powered by battery, followed by a rapidly expanding market for petrol and diesel vehicles, the mainstay of the current industry. Examples of electric taxis include the "Hummingbird", a battery powered taxi properly called the "Bersey", entering mainstream service 1897[3]. The Bersey taxi is recorded as being the first self propelled taxi licensed for use in London, with a fleet of such vehicles operated by the London Electrical Cab Company. The Bersey taxi was limited to a range of 30 miles between charges, highlighting a difficulty in use of electric vehicles, which remains to this day. Modern equivalents of the electric taxi include the Zero Emissions Vehicle being developed and tested in the UK market by Allied Vehicles (an electric taxi based on the company's E7 London Taxi design). The Bersey taxi suffered from poor reliability[4] and was replaced with the emergence of petrol vehicles.

The first petrol-powered taxi was produced by the French manufacturer Prunel, and introduced to Paris and London fleets from 1903. The Prunel taxi was followed, in the UK, by a wide range of taxi designs from other

[3] See: http://www.canadiandriver.com/articles/mj/taxi.htm
[4] See: http://www.lvta.co.uk/history.htm

manufacturers. The wide range of differing designs led, in London, to the Metropolitan Conditions of Fitness (MCF), introduced in 1906. The MCF regulations set standards for vehicle design including the requirement for a taxi to be able to make a complete U turn within a 25-foot roadway. These requirements effectively discounted a number of vehicle designs from taxi use restricting the available vehicle types to specific taxis, which have since become known as a "London taxi" type. Metropolitan Conditions remain to this day and continue to prove controversial, particularly with the strict application of a tight turning circle effectively ruling out some production vehicle types. A number of UK cities, in addition to London, have chosen to adopt MCF conditions as a control on the design of vehicles in use with varying strictness, particularly in terms of turning circle requirements. Licensing Authorities in Liverpool upholding, in 2008, the strict need to adhere to a turning circle requirement; while other UK cities, which apply MCF principles, have dropped this requirement, including Edinburgh in 2007.

The fitting of taximeters became a requirement of the London fleet in 1907 predicating the widespread use of the term taxi (after the taximeter) for all such vehicles.

The current Black London Taxi design emerged in 1948 with the development of the Austin Carbodies FX3, the forerunner of today's dominant London vehicles. The FX3 and its replacement FX4, from 1958, defined a standard purpose-built taxi flexible to the extent that engine and drive train parts could vary while external appearance remained constant. The final version

production FX4, the Fairway, ceased production in 1997 following a run of over 75,000 such vehicles. London Taxis International, the successor to Carbodies, continues to this day to produce purpose-built London taxis, currently marketing the TX4 model (2007 – present).

(Insert Image 1.1 – London Black Taxi)

Figure 1.1 LTI TX4

UK taxi design differs significantly outside London. In most metropolitan cities a form of consistency is applied, based on a number of interpretations of the MCF approach adapted from London, ranging from strict controls, as applied in Liverpool, to more generous interpretations in Glasgow, Edinburgh etc. The latter have a greater flexibility in the range of vehicles available and allow the Allied Vehicles E7, ostensibly a London Taxi, but unable to perform the turning circle requirements set in the stricter interpretation of the MCF. Smaller cities in the UK split between those requiring London styles of taxis, and those permitting saloon (sedan) vehicle types. Current discussion focuses around the relative merits of one vehicle type over another for the types of journey made by location. The argument is further complicated by a desire, of some authorities, to provide accessible vehicles, and legislated requirements requiring, but not defining technical standards for, accessible vehicles.

In North America Hackney Carriages (Hacks) were a popular form of transport in the early Nineteenth Century. Waves of immigrant incomers adopted the trade as a method of gaining employment, leading to ethnic

succession from indigenous to immigrant dominance. Not all such successions were peaceful, with hack drivers earning a poor reputation for aggressive solicitation and anti-competitive practices.

Hansom Cabs became popular with the founding, in 1869, of the Hansom Cab Company in Brooklyn, New York. Electric vehicles made a brief appearance including a fleet of electric hansom cabs introduced in 1897 by the Electric Carriage and Wagon Company.

In 1907 a New York entrepreneur, Harry N Allen, introduced a fleet of petrol taxis imported from the French manufacturer Darracq (Hodges, 2007), operating a fleet of 65 vehicles employing contracted drivers each required to wear a uniform "designed to emulate a West Point cadet". Allen's business model introduced a level of control to the supply of taxis in the city and included the requirement for uniformed drivers and specified distance based fares, determined using pre-set taximeters reducing the opportunities for price abuse (US: price gouging). Allen's taxis are also reported as the first taxis to be painted yellow, reportedly as a result of yellow being the color most easily seen from a distance. Problems emerged a year later, in October 1908, with the onset of labor disputes, between drivers and Allen's company in a dispute seeking union representation and higher salaries (See Schaller, 2006).

Standardization of vehicles followed, with the development, from 1910, of the Yellowcab, a design manufactured by John Hertz who both built the vehicle and operated a taxi business, using excess vehicle production to form a car

rental business (initially called "Yellow Drive-Ur-Self, and latterly Hertz Rental Car).

Morris Markin, who both manufactured and operated taxis under the name Checkercabs, and was to take over the Yellow taxicab company in 1929, adopted a similar approach. The 1956 Checker A8/Marathon became the most popular taxi vehicle in the USA, continuing in production until 1982 and forming the basis for subsequent standard taxi designs, and informing the current dominance of the Ford Crown Victoria and Lincoln in taxi use, Lincoln using a taxi derivative of the production "Town Car". In 1960 the City of New York legislated that all vehicles be colored Yellow, although this differs in other cities, and does not cover all taxi types in New York.

In 1964 the State of New York filed antitrust charges against Markin highlighting the anti-competitive position of Checker Cab having dominance in manufacture and operation of taxis.

Similar patterns of development are observable in other countries, while some locations offer distinctive and distinctly different forms of taxi. Differences arise from the form of licensing adopted, this being adherence to a dual system of taxis and PHVs; alternative license forms including Taxibus and Limousines; but will also relate to the market forms, typically the dominant methods by which taxis are engaged.

1.3 Market form

The split between licensing types highlights the fact that taxis provide services for different constituencies. The two most popular taxi categories, Hackney Carriage and PHV actually provide services to three market segments, hailed journeys, journeys engaged at taxi rank, and taxi journeys booked in advance (by prior arrangement). In locations that distinguish between Hackney and PHVs, the latter may be restricted to pick up by prior arrangement only, while some concessions exist allowing PHVs to operate on demand from specified depots.

Hailed journeys, as with journeys starting at a taxi rank (UK: Taxi Stance / Taxi Stand; US: Cabstand) are based on immediate engagement of a vehicle, and both rely on the supplier offering to supply services, typically at points of high demand. Licensing authorities have a role in determining the location of taxi ranks and in their maintenance, often with direct input from taxi operators and companies. The balance between stands and hailed traffic remains a local choice and will often affect the dominant forms of taxi operating patterns in a city. Most UK cities favor the identification and maintenance of taxi stands and there are over 500 taxi ranks in London at the time of writing. Taxi stands may also provide a focus for particular uses such as providing a safe location for taxi engagement at night. The Glasgow Nitezone is an example of marshaled policed taxi stances introduced in 2005 and highly popular with both passengers and drivers alike.

Pre-booked (US: dispatched) taxis represent a third method of engaging taxis and are often dominated by PHVs, vehicles only licensed to operate by prior arrangement. The pre-booked market has developed significantly in recent years with the advent and widespread use of mobile phones allowing for faster bookings, removing many of the barriers associated with pre-booked vehicles particularly in reducing delay.

The third and fourth license types, taxibus and limousine represent a smaller market than for Hackney Carriages and PHVs, but have significant roles to play. The Taxibus (Jitney / Shared Taxi) has developed as a relatively new form of service in the UK, and has become established (CfIT, 2008) as a part of a market for Flexible Transport Service (FTS) with particular benefits in rural communities. The idea of a shared small vehicle, however, owes much to the Jitney and Camionetas (Bush Taxi) frequently providing collective transport in developing countries.

The Shared Taxibus (Jitney) is an intermediate form offering journeys to individuals and small groups in multiple occupancy, often using traditional taxi vehicles. Traditional taxi licensing authorities and operators in developed countries have tended to avoid permitting such operations, in part due to the additional difficulties of determining multiple fares in a single journey compared to sole vehicle hire. The taxibus does, however, play a significant role in transport in developing countries and in locations where more traditional modes are inadequate to need.

The Jitney owes its name (Hodges, 2006) to a practice arising in Los Angeles, in the 1914 economic downturn, to offer rides for 5 cents (US slang: a Jitney). The practice led, in a number of US cities by the development of public transit authorities responsible for planning for local public bus services. Valenzuela et al (2005) describe "Camionetas" (Lit: Mexican: minivans) as privately operated jitney services operated by and for immigrant populations, partially as a response to a lack of public buses, but also as a response to US limitation to incoming populations to obtain driving licenses. Although many such services operate they are, in the main, illegal. Cervero (1998) argues that the informal privately operated Jitneys offer a complementary service to operate alongside existing public transit, citing Mexican examples of legalized "colectivo" a community based jitney service, as offering potential for development in the USA.

1.3.1 Taxi Ranks

The primary objective of the taxi rank is to define a location at which prospective passengers may engage a taxi. The rank may be perceived as offering a likelihood of taxis being available, as opposed to a greater uncertainty in engaging a taxi by hailing on street. The taxi rank also offers a benefit to taxi drivers as the location at which intending passengers will congregate.

The very first references to ranks can be seen in the 1654 Taxi Ordnance, specifying a power to the Court of Aldermen, in London, "concerning the distribution of coaches"…"their places of standing". Early references in the US exist in relation to Allen's New York operations, in 1907, originating at a central hotel stand, though it is likely that the concept existed in America significantly prior to this time.

Current uses of taxi ranks differ by location, although the primary concepts and understandings are the same. Responsibility for stands in GB lies with the Licensing Authority, who will determine the most appropriate locations and specification, in terms of numbers of vehicles permissible etc. Ranks tend to be limited to a predetermined number of vehicles, with physical dimensions based on this number. As ranks may, in reality, occupy valuable space in central city locations, disputes are observed between the taxi trade and licensing, and sometimes parking, authorities. Some UK cities report disputes between taxi drivers and private parking enforcement companies where larger taxis exceed the space allocated to their use and this has led to issuance of parking fines for vehicles within the numbers specified for rank capacity. It is also noted that on occasion, and in instances where stand capacity is limited, taxis may congregate in sight of but away from permitted ranking space.

In a number of cities (including Belfast and Glasgow) the presence of illegal taxi ranking can be observed. Illegal ranks can exist either as a location where legal taxis congregate without official sanction; or locations where illegal taxis congregate without official sanction or correct licensing. A grey market exists

for the latter; in instances where PHVs operate as though they were licensed for rank pick ups, which, in the majority of instances, they are not. The practice, which is against licensing conditions, can sometimes serve a purpose of providing additional transport at points of peak demand and may, as such, be tolerated.

Recent moves have seen the deployment of taxi marshals at taxi stands, ostensibly to assist passengers, but likely to also add an element of security, and where appropriate traffic control. The taxi marshal originates in the USA from the tradition of controlling traffic flows manually, an imported approach (Regenold, 2007) taken from the 1868 introduction in London of semaphore signals. Traffic officers in the US sought to emulate and later copy semaphore and colored light signals for directing traffic, a forerunner to modern traffic lights. Little, if any, consideration of taxi controls existed other than a need to maintain existing traffic laws, until the development of controls on taxi flows in US airports arising in the 1970s, and largely as a result of increased need to control competing companies (see Chapter two). In reality, today's taxi marshal actually undertakes a significantly wider range of duties than simply regulating traffic flow. Most of the current UK examples of taxi marshals at rank can be traced to the period from 2003 (see Manchester, 2007), as the need to reassure the public of safety at night emerged as an issue in the use of taxis. Taxi marshals provide a control on the (excess of) behavior at taxi stances, and are popular in many urban locations (on line reports from Swansea, 2005; Manchester, 2007). Taxi marshals also impact, in some cases having a significant impact, on the performance of the stance, by effectively

offering the same traffic direction benefit, albeit applied to taxi operation, as identified in the US in 1868. A similar benefit is identified in relation to using taxi marshals at airports (see: Cooper, 2005).

Ranks located on private property, including those at airports and railway stations are not subject to the same requirements as municipal ranks, and can be made for exclusive use of specific companies.

1.3.2 Hailed Taxis

The concept of hailing a taxi has an equally long standing to taxis at ranks. Hailed taxis ply for hire and are engaged by an intending passenger flagging down an unoccupied taxi. In most instances the same vehicles operate within ranking and hailed markets, but this can vary by location. In addition the numbers of ranks available, and a particular city's attitude toward stand provision may influence the actual numbers of vehicles that are hailed, rather than engaged at rank. In some locations, particularly US cities, and highlighted in New York City, a strong predominance of hailed taxis is observed (TLC, 2007).

Accounts of hailing a taxi appear throughout English Victorian literature, including in Sir Arthur Conan Doyle's Sherlock Holmes stories, making reference to both Sherlock Holmes and Dr. Watson hailing taxis throughout London. The Hansom cab also appears as title in the "The Adventure of the

Hansom Cab" - the third and final story in Robert Louis Stevenson's The Suicide Club cycle, first published in London Magazine in 1878.

Neither cabstand nor hailed markets allow for sufficient competition in that no opportunity, or limited opportunities for negotiation exist at point of engagement. This represents an element of market failure and is the basis of price regulation (Schaller 2006) as discussed in chapter two.

1.3.3 Dispatched Taxis

Taxis available for pre-booking are a more recent innovation arising from the development and widespread use of telephone and radio technologies. The dispatch taxi is centrally controlled by a central office, dispatcher, usually allocating vehicles to the nearest or most appropriate vehicle.

Some reports suggest dispatch taxis entered service with the advent of radio equipment from the 1950's. Other records suggest the earlier use of a taxi call box, similar to police call boxes, located at taxi ranks allowing cabbies to pick up bookings.

Recent innovation in the use and control of dispatched taxis has emerged with the advent of satellite positioning and more elaborate communications systems between vehicle and dispatcher. Current systems include GPS location and tracking allowing a dispatcher to have a detailed view of vehicle positions and

status. Widespread use of mobile phones has also increased the numbers of dispatched vehicles being used, allowing for significantly reduced delay in booking a dispatch taxi.

1.3.4 Limousines

Although not often considered to provide taxi services, many countries include limousines within the area of taxi licensing. Limousines appear within some UK taxi licensing regulations (See: DOE, 2006), and are specifically included in the Taxicab and Limousine Commissions of US cities.

The definition of a limousine varies, and can be traced to a coach building technique developed in Limousin, France, as a process for covering open coaches with tarpaulin. Limousines as an up-market transport form emerged in New York in the 1920s with the development of a Limousine business by J.P. Carey. Luxury vehicle types were developed and subsequently made famous in Hollywood film productions; including the use of a 1929 Isotta Fanschini built luxury limousine in the 1950's film Sunset Boulevard.

Stretched Limousines, vehicles with a significantly lengthened wheelbase, developed in New York following a taxi strike led by the entrepreneur David Klein.

Some cities and licensing authorities also include Shuttle services within their definitions of limousines, these being multiple occupancy vehicles often operating between airports and hotels and including the US Airport Shuttle services, the latter having a resemblance to definitions of Taxibuses in some UK authority areas.

1.3.5 Shared Jitney and Taxibus

The shared taxi is emerging as a significant form of transport in a number of locations in developed countries, but actually owes its development to the Jitney operations of the 1920s in Los Angeles, and to the more widespread development of bush taxis, predominantly in West and Central Africa.

Bush taxis are attributed to a variety of origins, with the French name: "Taxi Brousse", being identified by some as the origin of the term. The Bush Taxi is defined as a mini-van or open van operating a fixed route without a timetable; literally departing when full. The method of operation is common in many African cities and particularly observed in suburban locations without regular traditional public transport with the Bush Taxi filling the gap left or not filled by service buses. Similar historical development is sometimes aired in relation to the Black Taxi Taxibus operations in West and North Belfast, attributing taxibus operations to a lack of service buses during points of civil unrest[5].

[5] The Northern Ireland "troubles" had led to a number of bus hijackings during the period in the 1970s. As a result the state bus operators, Ulsterbus and Citybus withdrew services from flashpoints.

Other examples of gap filling include the Camionetas operating in the Southern USA and Mexico, Colectivos in Argentina, and Dolmuş in Turkey.

Although many Taxibus operations have emerged from necessity and a number operated without licenses, there has been an effort to bring the mode into legality. Operations in Hong Kong, the Public Light Bus, have always been legal, while those in other western countries have been brought into legality, including the development of the Taxibus license in Northern Ireland.

New examples of shared taxi have emerged as local authorities seek to develop and provide access to remote communities (CfIT, 2008), and include subsidized taxis (Highland Council), and the Transport to Employment (T2E) shared taxi services in Scotland and Northern Ireland[6]. (Chapter nine)

1.4 The Taxi Company

As the forms of taxi licenses developed, and with changing pressures over regulation and its reform, so the nature of the taxi companies offering services has changed. In his US city-by-city analysis Mundy (2007) identifies a common framework of firm types, basic structural definitions by which the state of a location's market can be assessed. Firm types vary between the total taxi company, responsible for the majority of operational and personnel

[6] See: www.t2e.org.uk

functions of a large employer, to the permit only lessor, a single individual responding independently and owing their own account. The result is a continuum of operating patterns varying between taxi company orientation and individual driver orientation. The shape of the market and the orientation of its companies and owner drivers will, at any one point in time, reflect the development of the market and the historical conditions of the location.

The total taxi firm emerged in the USA with the New York businesses of the early 1900s. Allen's New York Taxis, established in 1907, employed drivers setting standards for appearance and operating practices. The total taxi firm offered a significant benefit in comparison to the cut-throat "Hack" market of the time providing a level of security to drivers, though this also led to conflict in Allen's case with the company's unwillingness to accept union representation. The Checker and Yellowcab companies also emerged as strong players.

Only a few major American cities currently have total taxi firms (are dominated by single, all encompassing, companies) which include Las Vegas and Reno, both in Nevada and beneficiaries of state (rather than city) regulation. It is noted that both benefit from local market conditions that make the employment of employee drivers economically feasible. No UK city has a total taxi firm, most operating taxi firm / permit lessor or owner operator models, though many of the representative functions described in the US specific to this operator type exist in UK cities as a result of Taxi Owners Associations (TOA) or taxi groupings (e.g.: Glasgow Taxis Ltd.).

Taxi drivers as employees remains a costly option, and a second tier, taxi firm/vehicle lessor has emerged. At this level some taxi firms retain all the service and obligations of a total taxi firm, such as insurance, vehicle ownership, computer dispatch, service agreements, etc., but elects to lease its fleet vehicles to independent contractor drivers, a practice that has been successfully challenged in UK courts. A level two firm can be just as effective and efficient as a level one firm, since it retains title to the vehicles and assumes risk by owning these assets. Such firms are most likely to engage in activities that promote the use of these assets and hence drive the incomes of their drivers. However, there is a potential for loss of control over drivers since they cannot treat them like employees. Independent drivers are free to decide whether or not to accept dispatched trips, the controller offering, rather than instructing, a passenger trip.

Benefits arise in the second tier from reduced liabilities (no employee taxes, wages, liability for driver accidents, etc.) and an economic gain for the independent contract driver that now has greater control over his/her working hours, personal customers, etc., there is a potential for loss of absolute control. The category also shifts the decision of hours of work onto the driver, since after leasing the vehicle for a prescribed period, usually a seven-day period, he/she has the option to work none, some, or all of the hours for which the taxi vehicle is leased. Resulting excessive hours – a profit maximizing behavior, has led some cities to pass ordinances defining maximum driving hours permissible. Large British cities with similar structures (category 2) may differ

in vehicle utilization, particularly reflecting a more common use of multi-shifted vehicles i.e. those shared between drivers. Multi-shifted vehicles have better utilization but restrict the actual availability of drivers to those hours where a vehicle is available.

An additional problem may arise where drivers decline bookings (a driver being able to decline at will) a move which will reduce their income without further personal loss, whereas the booking company may be required in law (in the US under an operator's Certificate of Convenience and Necessary) to accept bookings, and stand to lose both income and reputation where such a booking is not fulfilled. This is particularly relevant to out-of-the-way locations and/or high crime areas - often classified as undesirable trips.

Category 3 firms 'Authority and Call Center Lessor', as license owners, will lease permit(s) to independent contractor drivers who bring their own vehicles to the firm. This "asset light" approach is common where former category one or two taxi firm, experiencing financial difficulty, will first shed employee drivers, then vehicle ownership along with repair facilities in order to shrink the cost of doing business. Such firms retain dispatching and other traditional functions, and often include well-run taxi co-ops, providing group insurance and dispatch functions. These operations can sometimes be full service taxi companies if the co-op is well managed and their managers develop long-term business and orientation to their business. Medium sized UK cities will often include a small number of category 3 firms operating a majority of a fleet.

This includes both license owners and more simple cooperatives existing to provide common dispatch and group insurance.

A negative issue may arise, and is seen in a large number of US category 3 firms, where the permit owner has limited incentive to provide dispatching or marketing, other than perhaps a listing in local yellow pages. Such a firm may not offer a genuine 24-hour radio service, nor have incentive to invest in advertising, computer based zone dispatching, service contracts, credit card, or voucher support.

The forth category is that of the single permit owner/operator, operating individually (UK: Street Taxi). The holder of the permit is also the driver and may typically not have availability of radio dispatch or the extent of service contracts negotiated by higher-level firms. In this scenario the taxi is likely to concentrate on city stands, hotels, and airports (unless otherwise restricted). American experience suggests that the category three operator will concentrate on business at an airport – waiting two and three hours between trips, while UK regulations at airports tend to be more restrictive with street taxis concentrating on city centre cabstands. Large numbers of street taxis increases pressures and responsibilities for additional controls to be applied, seen in the US where an airport or the city becomes the de-facto personnel department for these drivers. It becomes the city or airport's responsibility to screen (issue a permit), manage conduct (enforcement of ordinances), and discipline as necessary (issues citations/violations).

Furthest away from the traditional regulated taxi firm is category 5 "Permit Only Lessor", where an individual owns a license but does not drive. The permit holder covers permit or license fees than leases it to the independent taxi driver who must provide his own vehicle, insurance, maintenance, etc. In essence, the permit holder provides no additional economic value to the permit other than to lease it to a driver and inspected vehicle. In this scenario, the city or airport again assumes the role of being the personnel department for the independent taxicab drivers. In addition, the airport under this scenario also becomes the stand dispatcher for these taxicabs when they operate at the airport.

1.5 How do historical developments inform current operations?

This chapter presents an overview of the history of taxis. Although many of the issues addressed have long standing historical bases they also represent and inform the current delivery of the mode. The history of the mode plays a significant role in its current operation.

The longest standing traceable history relates to the controls and regulations applied to its operation. In the UK controls applied in 1654, setting limits to numbers and quality requirements, have clear resonance with the current legislation and today's arguments over regulatory reform. Other countries also share a significant history in control. In Sweden reported regulations date back to 1859 to legislation from the Stockholm government setting maximum fare

levels (see: Marell and Westin, 2002). Chapter two explores, in more detail, the nature of controls in the UK, the USA and elsewhere and the significance of limits, set over three hundred years ago, on the supply of taxis to date.

Vehicle types, design and the need to fulfill fitness conditions (MCF) remain in place to date from their origins in 1906, and continue to inform which vehicles may be used as London taxis, with distinct parallels in the de facto standards applied in the USA. Current discussions relating to the carriage of wheelchairs continue to be influenced by the MCF rules, and these are also significant to the types of control applied.

Vehicle type requirements as well as limits on the numbers of vehicles allowed to operate in an authority area have also led to the development of a series of analytical tools, sometimes called taxi models, arising directly as a result of the legislated conditions of service, and set out in more detail in Chapters three and four.

The book continues to address the practical operating environments in which taxi companies exist. The next chapters detail the current daily environments in which taxis supply services and addresses the current and potential developments within the mode.

Chapter 2 The Development of a Licensing Structure

Introduction

The history of the taxicab is significant to its current form. Taxi service is the first readily identifiable form of public transport, first licensed in the UK in the 17th Century, and continuing to operate under legislation dating from 1847. Moreover, as the form of licensing has evolved only slowly, in part due to the mature and instantly recognizable nature of the industry, the historical legacies impact significantly on the current supply and potential future development of the industry. Regulations, the legislation impacting on the supply of taxis, have emerged as a result of the history of the taxicab and are commonly applied to the numbers of vehicles licensed (quantity control), to vehicle and operator fitness standards (quality control) and to their fares (economic control), collectively as QQE.

Both US and UK authorities widely apply regulation of taxis, with similar approaches adopted elsewhere. UK taxi regulations apply, following a similar approach to that in the US, to cities and local authority areas defined as licensing authorities and follow the same guiding principles – protecting the public interest. Taxis within the UK operate as a transferred matter, an area of legislated business passed from the Westminster government to the regional government assemblies in Scotland, Wales

and Northern Ireland, though a different pattern of responsibilities apply to some areas affecting taxis, such as the application of reserved matters, including disability rights legislation. Regional legislation can be, and usually is, further delegated to local licensing authorities, except in Northern Ireland, where taxis remain at the devolved government department level (DOE).

2.1 Why Regulate Taxis?

One could argue that everyone needs other generally available goods and services such as grocery stores, restaurants, and even car rental firms in addition to taxi service. However, they are not economically regulated in the belief that competitive forces will bring about quality operations and the best consumer prices if government intervention is kept to a minimum. Why then is there the need to regulate taxi services?

The necessity to regulate taxi services is really two-fold. First, in the U.S. and Canada, there is a legal responsibility prescribed by the State or Provincial Legislatures that cities within their geographic boundaries may be, or in the case of larger cities, are required to not only ensure the safety of public taxi passengers, but also to economically regulate the provision of public taxi services.

The second, and somewhat intuitive, but yet most effective, reason for regulation of taxis is the rationale that it is in the public's interest to regulate taxicabs, the absence of regulation resulting in a lower level of service to the consumer. There is the social commitment that a community has to its citizens and visitors alike that this vital

public transportation service will be available, safe, and economical to use. Rates are balanced to protect the user from onerous or arbitrary fares but to still yield the provider sufficient funds to continue in business and make a modest profit.

The common approaches to controls are, however, mixed and tend to vary between pressures to regulate, and those seeking to deregulate, including de-listing – the removal of quantity controls, and more comprehensive deregulation – which are likely to remove economic price controls. While the issues surrounding removals of restrictions are addressed in more detail in a later section, it is appropriate to comment that many academic research studies in both the USA and UK have observed that a comprehensive deregulated or completely open entry approach to taxi services within a community can lead to unreliability or more expensive taxi services.

Following the onset of regulation in London from the 17th Century and in the United States during 1930's, regulation of taxis has been adopted widely to stop shady tactics and practices of individuals who over-populated the supply of taxis and often fought territorial wars for passengers on the public streets. Like any good transportation service, taxi services must be appropriately planned for, co-ordinated, and continually upgraded if they are to attract and support a customer base, while public interests include a desire for appropriate charging, a lack of abuses of customers and indications of safety.

Another very important reason for regulating taxi services is the public image that is conveyed to residents and visitors alike (quality controls), although these may be applied individually or as a sub-set of more comprehensive controls. In this respect,

the taxi conveys a very strong image of a city, with a number of authorities seeking to enhance a reputation or feel from the quality of their cabs. Community leaders want their city to be considered progressive and "upscale". They want to be viewed as places where people can live and enjoy the amenities within the community. Many community leaders work hard to develop a positive image – one of clean, modern, and progressive community values. This is especially true for communities that are considered tourist destinations in North America and those who wishing to be known as a retirement destination. The UK's adoption of MCF standards, typically requiring the use of London style taxis, is observable in larger cities and this has been correlated to a desire to maintain a quality standard in the taxi fleet.

It is both the public's need and preference to also have a modern, positive image for its taxicab operations. Community leaders can be seen to desire a taxicab service that reflects a city's desire for clean, efficient, and responsible public transportation services. This includes a taxicab service that meets the needs of all its residents and visitors alike.

2.2 Early Regulations

The early regulation of local taxicab services in North America followed the general format of transportation regulation set out in the 1874 U.S. regulation of railroads, known as the "Interstate Commerce Act" (to be applied by an Interstate Commerce Commission - ICC). Historians generally agree that the Act to regulate railroads came about mainly due to excessive abuses of enormous power these railroad executives

held over farmers and manufacturers. By setting rates on their railroads, these early corporate heads could favor one area or one manufacturer over another, thereby negatively affecting their ability to compete in the marketplace. It was the early movement of farmers who passed state laws, referred to as the Granger Laws, against the railroads that convinced federal government officials to step in and declare that setting of rail rates which moved products from state to state to be the rightful affair of the federal government.

Eventually, additions to the initial ICC legislation gave the federal government the right, through regulation, to control the entry, exit, rate making, and financial dealings of U.S. railroads. Motor carriers were added as Part II of this Act in 1935. In general this legislation gave the federal government in the U.S. the right to regulate "interstate commerce" and the companies that moved products that were considered to be interstate movements – i.e., moving products from one state to another. In order to regulate these movements, the Interstate Commerce Commission (ICC) was created to regulate entry through "certificates of convenience and necessity", set rates on movements through rate hearings, and administer to the overall financial health of the industry.

During the Great Depression years, state governments became concerned about transportation territorial disputes among taxi companies. Local taxi companies, which had grown considerably since being introduced to almost all major U.S. cities in the 1920s, were experiencing labor disputes and bandit cabs that proliferated during these stressful financial times. These disputes disrupted local commerce and often spilled over into violence. "Bandit" cabs operating outside regulation, including those

offering black market (illegal) and grey-market (of uncertain legality) could undercut legal operators because of their lower levels of insurance (if any) and lower standards of vehicles. Taxi protests also became a popular way for taxi drivers to express their concerns.

New York City, for example, in 1934 experienced what some consider one of the largest labor strikes in history in 1934 when more than 2,000 taxi drivers occupied Times Square in protest of their conditions. As a result, New York City passed the Hass Act of 1937, setting up a taxi medallion system that remains largely in place today. Taxi driver protests remain a method of expressing concerns over licensing choices, including recent protests in Belfast (2006) and Dublin (2009), the latter protesting about the numbers of licenses being issued, and seen by the taxi drivers as excessive.

Most state legislatures during this time followed the lead of the federal government, and they dropped the laissez-faire approach to business in general, and transportation specifically, in favor of regulated monopolies. Thus, most states passed some form of intrastate transportation regulation that often included local taxi service or, in the case of some major cities such as New York, provided for these cities to regulate intra-city or local taxi operations.

2.2.1 State Regulation

Similar to the federal level ICC mentioned above, these state laws created Public Service Commissions, or similarly named authorities, to regulate intrastate

transportation. In many states, this also included the regulation of local taxi services although the typical taxi company served mainly one city or provided the authority for cities to set up their own taxi regulatory schemes. These regulatory bodies were granted the same powers over intrastate and local movements as their counterpart at the federal level - the ICC.

From the late 1930's through the 1960's the majority of these regulated transportation firms at the federal, state, and local levels enjoyed the benefits of being regulated monopolies, duopolies or in the case of taxi companies, a small oligopoly of only a few firms with the appropriate certificates of convenience and necessity. Many cities existed for four or more decades with the same number of taxi firms and taxi permits even though population, automobile ownership, travel patterns, and taxi usage may have changed considerably – both positively and negatively for taxi demand.

During the depression years, U.S. governments at the federal, state, and local levels were concerned about removing the street level competition for transportation services. By permitting only a few financially capable providers in each market to provide service, it was felt that stability and long term growth of both these firms and the general economy would prevail. With the evolution of unionized labor in most of the U.S. transportation industry, it was also felt that there was a balance of power between labor, management, and capital - that profits from these regulated companies would be dispersed to labor, management, and investors in a fair and equitable manner.

By setting rates that provided for the cost of operations plus a profit that was usually slightly more that the cost of borrowing money, it was also felt by transportation regulators that the interests of the public were being served through the lowest possible rates or fares. Thus, the "implicit compact" between the regulated company and its regulators was forged. This compact was that if you (the company) are willing to be regulated and have your rates set by us rather than by you, then we (the regulators) will see to it that you have a fair rate and we will protect you from ruinous (undesirable) competition.

Entry into these regulated transportation industries became a difficult if not impossible hurdle to achieve. In order to be granted new authority to provide motor, bus, taxi, or later, shuttle service, the applicant had to prove that they were: (1) a fit and worthy company or individual, (2) that there was a market that was not being served by the existing carrier(s) that would be serve, (3) that existing carriers would not or could not serve this market, and finally (4) that your entry into this market would not financially harm the existing carrier(s). With this burden of proof, it is easy to see why only a very few applicants actually obtained new operating authority.

2.3 Transport Deregulation

The 1970's, introduced a general era of transport deregulation within North America. Railroads were floundering under the ratemaking decisions of the ICC. Equipment was old; infrastructure was deteriorating faster than the financially strapped railroads could maintain it, and service was generally poor. Motor carriers had taken the vast majority of high-value traffic in most products and commodities away from the

railroads although railroads possess an inherent advantage of lower transportation costs. Speed, flexibility, and reliability of delivery had become more important to shippers as they turned from rail to motor carriage. Longer, unreliable travel times by rail meant more inventory carrying costs to manufacturers often to the point where the higher transport costs by trucks were more than offset by the lower inventory carrying costs.

The problems associated with transport regulations became obvious to many economists and even to U.S. Presidents. John F. Kennedy called for the deregulation of domestic transportation as early as 1962, citing the need to return competition and financial health to these industries. The primary problem stemmed from the rate setting actions of regulatory boards that often failed to consider the costs associated with infrastructure repair, the need for newer equipment, and reasonable profits to attract capital.

In addition, the unionization of the trucking industry, coupled with its protection from competition, led to outsized driver incomes and thus, overall transport costs. Individual firms could and did provide their own transportation by trucks cheaper than the regulated common carriers – although their trucks were, by law, not permitted to handle any other goods and had to return empty! Private carriage (fleets) became a major segment of the trucking industry during this time.

As a result, the railroads, motor carriers, and airlines were deregulated at the federal level through a series of Congressional Transportation Acts from 1976 (Railroads), 1978 (Airlines) and 1980 (Motor Carriage). States soon followed with deregulation

of their intrastate transportation Acts also. Local laws dealing with regulated taxis were not far behind.

The following examples drawn from the experiences of U.S. cities provide an illustration as to how sudden deregulation could occur.

2.3.1 Orlando, Florida, USA

The City of Orlando, Florida had experienced considerable turmoil in its taxi operations between the years of 1960 and 1980. In October of 1980, the U.S. Department of Justice, Anti-trust Division instituted a civil investigation against the Mayor and City of Orlando to determine if there had been a "Conspiracy to restrain trade in the transportation of passengers by taxicab." This inquiry led to the creation of a Transportation Permit Board and the city's current taxicab ordinance (Chapter 55, "Vehicles for Hire"). As a result, the City Council permitted new taxi firms to be established, and the number of taxicabs permitted to operate on Orlando's streets was increased substantially to 220 taxis. Subsequently the City Council of Orlando requested that the TPB consider the ownership of taxi companies to reflect the social policies of the City. The new taxi companies that were formed by a lottery of new permits were granted based on ownership by gender (female), race (minority) and cultural diversity (ethnic origin).

2.3.2 Other Cities

Other U.S. city officials viewed the taxi deregulation movement as a way to both spread out the ownership of these companies to minorities and as a way to secure revenue for the city. In Atlanta, Georgia for example, in an attempt to deregulate the taxi industry, a medallion-style system was established in 1979. In 1982, 1,582 Certificates of Public Necessity and Convenience (CPNC) were sold at an initial price of $ 100,000 per permit. These CPNCs were necessary for a taxicab to be able to operate within the jurisdictional boundaries that were established. Because these medallions were sold to individuals and not taxi companies, there was little need for the owners to belong to a taxi call center, so most simply leased their medallion to whomever wanted to drive a taxi.

By 2000 1,560 CPNC were used by working taxicabs in Atlanta. In 2000 the official estimated sales price was $ 12,000 but the unofficial one was nearly double that price, $ 23,000. This sales price was expected to rise to as much as $ 30,000 over the coming 5 years but has not done so. In fact, many believe it is worth less now. The only requirements for a transfer of a CPNC are a proof of insurance, a test of safety, a proof of emission, and the payment of the transfer fee of $100. The annual renewal fee is $50/CPNC/year. In 2000, Atlanta had 28 permitted taxicab companies in the industry. In order to drive a taxi in Atlanta the vehicle had to be associated with one of those 28. Every new company that wanted to start a taxi business had to buy or lease 25 CPNCs to do so (Guensler, 2000).

Today the value of the CPNC is thought to be considerably less than $20,000 and the market appears oversupplied, with the majority of taxis waiting between two and three hours at the airport for a fare. There is only one full service taxi dispatch firm

left in the city, and it runs fewer than 250 taxis citywide. Most feel the Medallion system, while having an initial boost to the City budget, has been a major failure in terms of service quality, delivery, and value for the city of Atlanta.

2.3.3 Denver, Colorado

A final example of state taxi deregulation in the U.S. can be found in the city of Denver, Colorado. The regulation of taxicab services, use fees, and driver fines is divided between the City of Denver and the state's Public Utility Commission (PUC). The City of Denver's Department of Excise and Licensing regulates the issuance of taxicab driver permits and city taxicab stickers. The City accepts an individual's application to obtain a taxi driver permit, does a criminal background check on the applicant, administers a test of English, knowledge of the city, and taxi driver regulation, and issues a taxi driver permit. This is done with a small, efficient staff. This City department does not, however, provide staff for the training of taxi drivers or the on-street inspection of the driver's behavior. These tasks are left up to the companies leasing vehicles to the drivers.

Economic regulation of Denver taxicab service, however, has long been the purview of the State through the Colorado Public Utilities Commission. Their approach has been classical economic regulation of a public utility, including regulation of entry, rates, service, financial dealings, and even exit. Perhaps the greatest controversy about this regulation has been entry regulation. It has come under the considerable pressure from State legislation over the years, as individual taxi drivers seek to start

their own taxi companies rather than leasing vehicles or operating authority from one of the primary taxi companies.

A detailed history of the taxi regulation in the Denver Metro Area is set out by the Colorado Public Utility Commission (Colorado, 2008). Denver taxi regulatory experience comprises:

1953 – 1994: Traditional Regulation: Doctrine of Regulated Monopoly

1994 – Current: Policy Change – Doctrine of Regulated Competition

1994 – Expansion and Consolidation

Since 1994, the PUC and other officials in Denver have struggled with the concept of regulated competition. The number of taxi company providers increased, and there appeared to be a feeling of comfort with this approach. However, when economic conditions arose whereby there was a consolidation of these service providers, considerable concern by public officials and others appears to provoke an annual discussion before the State legislature and the courts dealing with the concept of entry into the Denver taxi market.

In an attempt to provide rate flexibility and foster greater competition, the PUC set the maximum fare(s) for flag drop and per mile rates the same for all three taxi companies, but permited these operators to charge lower than the metered rate if they provide the PUC with a tariff of these less than the maximum rates.

European examples of regulation follow very similar patterns to those in the USA, but are often visible over longer periods of time. UK regulations emerged in 1654, (Chapter One), initially limiting the numbers of cabs in London, but continuing to determine responsibilities for enforcement (Town Police Clauses Act 1847) setting tariffs, and mechanisms for updating tariff and license numbers (Civic Government (Scotland) Act; Local Government (Miscellaneous Provisions) Act). The longevity of an enactment is highlighted by the fact that the 1847 Town Police Clauses Act continues to be in force and applied to taxis to this day.

2.3.4 Classical Transport Theory

Classical transportation entry regulation is based on the public interest being served by one or a few providers that have the size and equipment to serve a geographic market. It was typically argued that there was, or is, a minimum "economies of scale" or scope in which a firm could economically serve the market at the lowest cost to the consumer. If the market were viewed by the regulating agency as being most efficiently provided by a single company, such as with a telephone, cable TV, electricity, or water service, then only one provider was granted a permit or operating authority to provide the service. For example, in public transit in the US, both by State statute and local regulatory authority, it was and is felt today that a single traditional (public) transit provider is best. This is a transportation monopoly protected by statute. A further argument exists that a saturated market operating without full knowledge (market failure) may increase the incidence of market abuse and result in a reduction in quality and/or safety standards.

In the trucking or motor carrier industry, regulatory authorities had determined that some amount of competition was good for the shipping public, so would often permit two or more carriers to participate in an area or city-pair market with the expressed desire for the shipping public to have a choice of carriers. However, while carriers could compete on the basis of service, they all had to charge the same rate for these transportation services. Hence, this became known as the doctrine of regulated competition. Entry, however, was still controlled by the transportation authority and the obstacles to enter the market, as discussed above, were high but not insurmountable. Many state regulatory authorities granted additional permits for service when and wherever they felt the market required it. Indeed, this remains an option for the Colorado PUC today when regulating taxi companies in their states.

Fortunately, regulation of local taxicab service within the State of Colorado had been maintained at the state level and has not undergone open entry or major expansive deregulation. Generally, this reluctance to grant additional operating authorities has had a positive impact on serving the public's interest. Indeed, while city after city within North America underwent taxicab open entry deregulation, only to quickly re-regulate after fares rose dramatically and service deteriorated significantly, Colorado's cities, and Denver in particular, had been spared this fragmentation of their taxi industry and ensuing problems of having to rebuild their tattered taxicab services and image.

2.3.5 Theory of the Firm vs. Individual Behavior

Classic economic regulatory theories are also based on the assumption that the behavior of firms would be that of a long term interest in the consumer - that business is built over the long run through marketing, word of mouth, and personal experiences of the patrons of the services. All individuals, including the employees providing the services, are concerned about how the customer views the services so these customers come back themselves, as well as tell others about their positive experiences. It is assumed that, through trial and error, the good providers, like cream, will rise to the top, and that bad operators will sink to the bottom and go out of business – hence the classic competitive economic model – the best grow and prosper.

Within the taxi industry however, the employee in North American taxi firms has been replaced in large part by the independent contractor driver or, by an independent owner-operator who provides his/her own vehicle, insurance, cell phone service, etc,. Under this fragmented scenario, each driver may treat each customer as a one time patron, one he or she will never see again, so the temptation is always there to take a circuitous route, charge extra for bags, refuse short trips or credit cards, and even to overcharge if their income for that day is lagging. This is especially true for airport taxi drivers who acknowledge a visitor to the area is less likely to know the local geography and even less likely to return to the area, even if they make a formal complaint about overcharging.

Under this scenario there is no long run attitude of the service provider and there is often no repeat trial and error experience for the user – especially if the user is a visitor at the airport or an infrequent user of taxi services. Thus, under these conditions the classic competitive economic business model does not exist and just

the opposite happens – the bad and somewhat unscrupulous operators often drive good competitors from the marketplace.

Denver, Colorado, USA

While not undergoing such a de-fragmentation of their taxi industry as other cities have, Denver has had one serious interruption to their regulation of competitive entry by the PUC. This was a court case brought about by a group of drivers supported by the non-profit legal agency. By the late 1990's the taxi industry within Denver had consolidated through acquisition into only two taxi companies. Drivers sought to overturn the requirement to prove a market need for an additional taxi firm – that they only be fit and able to provide the service. As a result, a new taxicab company, Freedom Cab, was given an operating license for 50 taxis, later expanding through application to 150 taxis. This action increased the number of taxicab companies by one and the number of taxi permits by 19%. Thus, the PUC regulated three Denver taxicab firms. These are Metro Cab with 492 permits, Denver Yellow Cab with 300 permits and Freedom Cab with 150 permits.

However, additional taxi drivers wanting to start their own taxi company petitioned the Colorado State Legislature to change the entry requirements for regulated taxi companies to a significantly lower level. Applicants to Denver's taxi industry will now only have to prove they are fit and worthy and that they will not seriously damage existing carriers. Under this scenario, the PUC has decided to issue another 400 taxi permits – 300 to a new taxi company and 100 more to Freedom Cab and are considering more applications. Thus, the PUC will be adding nearly a 40% new taxi

supply in a city market that is already being well served. While not completely open entry, the results of this greatly expanded supply of taxis may have the same result as has happened in other cities that overnight deregulated their taxi industry. Indeed, the current action of the state taxi regulatory body is to significantly reduce current driver incomes and negatively affect the availability of capital to their existing taxi operators.

2.4 Taxi vs. Limousine Regulation

In addition to determining the appropriate number of taxi permits and companies allowed to be in business, local taxi authorities also face the regulator's question of competition from substitute forms of ground transportation – primarily the sedan or black car service. An example of this scenario was recently dealt with in Hillsborough County (Tampa, Florida).

2.4.1 Hillsborough County

The Hillsborough County Public Transportation Commission, (HCPTC), like many local transportation agencies, is vested with the responsibility of regulating private for-hire forms of ground transportation. By specific state statue, Florida Laws Chapters 2001-299, Section 2. (1) requires the HCPTC to regulate all public vehicles upon public highways of Hillsborough County and its municipalities. This includes taxicabs, limousines, and vans.

Commissioners of the Public Transportation Commission (hereafter, PTC) have the broad mandate to regulate these forms of transportation in the public's interest. As in the case of Hillsborough County, this general set of prescribed powers includes the responsibility and authority to economically regulate these forms of ground transportation. Such economic regulation typically takes the form of entry regulation requirements, prescribing fares to be charged to the traveling public and setting overall standards of performance by the authorized carriers and their drivers.

By far the most involved component in local transport regulation is that of taxicabs. Due to the need for private, for hire transportation to be available at all times of the day or night at reasonable rates, taxicabs are traditionally regulated with respect to market entry, metered fares, vehicle types and equipment, and driver behavior. This mode of ground transportation is considered to be a "common carrier" form of transportation available to the general public. Taxis are required and permitted to offer "on-demand" services either by being dispatched from a central dispatching office, waiting at a hotel or airport cab stand, or in some communities, by street hail.

Definitions as to what defines a taxicab vary by region. Examples in the USA are typified by that of Hillsborough county, set out below, with legal definitions in UK and Ireland included in the various governing Acts including the Civic Government (Scotland) Act, 1982; Local Government (Miscellaneous Provisions) Act, 1974; Taxis Act (Northern Ireland) 2008; and the Taxi Regulation Act (2003) in the Republic of Ireland. Hillsborough County defines a taxi as:

"…any motor-driven vehicle, equipped with a taximeter with a capacity for 6 or less passengers, including the driver, for the transportation of for hire passengers, which operates within the County, but does not include sight-seeing cars or buses, streetcars, or motor buses operated pursuant to franchise. Taxicabs can be one of two classifications: standard taxicab or luxury taxicab, unless otherwise indicated, use of the word "taxicab" within these Rules shall be meant to include "standard taxicabs" and "luxury taxicabs" collectively." (PTC Rules, Section 1.27 – Taxicabs, p.4)

Within Hillsborough County taxis are strictly regulated as to age and mechanical condition of the vehicle, number of permits, meter reliability, service quality, and overall appearance of the vehicles, etc. There are a number of competing cab companies offering a 24 hour per day on demand service. Taxis may also offer prearranged or contract service and they may charge less than the meter rate when operating under a contract for service. Overall it would appear that the taxi industry is healthy in Hillsborough County, offering a relatively high level of on-demand public transportation to the general public.

Generally taxis are the only form of regulated ground transportation that is permitted to offer "on-demand" services. It is felt that the public's interest is best served by standardizing this form of ground transportation service through the use of taximeters that charge the legal and lawful rate to the traveling public. These fares are, in almost all communities, required to be visibly displayed. In the US this is typically on the exterior of the vehicle so all prospective users may see, while the UK, as with Ireland, Germany and many other EU countries, require the display of tariff cards with the

vehicle. In this way users will always know what the fare per mile will be before entering the vehicle, in the US; or prior to agreeing to a journey, in the UK.

A common approach is also seen to promote taxis, and only specified vehicles, by unique color schemes and displays, including the use of a lighted dome (rooftop fixture) that indicates they are a taxi for hire.

2.4.2 Common vs. Contract Carriage

Also typical is the reliance of the general public upon the taxi regulating authority to enforce standards within the industry by regulating fares through meter inspections, safety of the vehicles through vehicle inspections, and driver integrity through background checks. In many locations, such as an airport, hotel, cabstand, or on the street, passengers expect to be treated fairly and to receive roughly the same quality of service at the same fare by taking the first cab in line. The general public is relying upon the regulating authority, in this case, the Public Transportation Commission, to have done all this for them and to keep other ground transportation firms from operating as "on-demand" taxicabs.

Limousines, on the other hand, are considered to be "contract carriers" whereby the user enters into a contract for service with the limousine company and is regulated as such. That is, there is the assumption that the vehicle is contracted for a specific trip, occasion, or time period, prior to the actual event. Prom nights, weddings, special occasions, etc., are the typical traditional services offered by limousine companies.

Only in a few cases, such as at a small number of North American airports, are limousine services permitted to offer "on-demand" service, whereby a customer can walk up to a sales counter and ask to be transported immediately by a limousine. Typically, this on demand market is reserved for taxis due to the need to provide a uniform or common carrier level of 24 hour service throughout the community.

Except for mandatory minimums, limousine rates may or may not be fixed by local regulatory bodies because it is felt by some local authorities that these ground transportation services are best served by encouraging competition among these service providers. Therefore, from a regulatory standpoint, it is typically easier to enter the limousine market where rates and services may vary considerably. It is expected that, due to competitive market forces, there will be turnover in the companies as some succeed and others fail. However, since this is a contracted service, it is felt that the average consumer can and should do their own research as to the quality of service, comparable rates, and dependability of the limousine company. Pursuant to PTC Rules, limousines within Hillsborough County are defined as:

"… any motor vehicle for hire not equipped with a taximeter, with the capacity of 15 passengers or less, including the driver. This definition consists of vehicles which are recognized by the industry as "luxury" vehicles, that are considered as high-end luxury vehicles by the manufacturer and vehicles that have been uniquely modified so as to provide "luxury" limousine service. The "luxury" quality of vehicles will be determined by assessing the aesthetics of the interior and exterior of the vehicle, amenities provided to the passenger, spaciousness and comparison to current industry standards for vehicles performing limousine service in Hillsborough County. Unless

otherwise indicated, use of the word "limousine" within these Rules shall be meant to include all varieties of limousines discussed in these Rules, collectively. Limousines can be sub-categorized as follows: a. "stretch Limousines" or sedan/SUV model that was manufactured or remanufactured with an extended wheel base or; b. "Limousine Sedan" or luxury vehicles with space for at least two passengers behind the driver and additional space behind those passengers for luggage, or; c. "Sport Utility Vehicles" (SUV) that are top-of-the-line models and have the luxury package options included to provide a luxury service, or: d. "Limousine Buses" that are used for passenger transport for-hire. These buses can have forward facing seating or can be modified for circular or "party" seating."(PTC Rules, Section 1.15–Limousines, p.3)

2.4.3 Competitive Rate Making

Historically there was little competition between limousines and taxis because they served different markets. Taxis were more for the everyday use of individuals that did not have the use of a personal vehicle and were not inclined or could not use public transportation to their destinations. Limousines were special luxury vehicles contracted for a specific occasion. Taxis charged by the (metered) distance and limousines charged by the hour. Taxis did have an hourly rate but this was for waiting time – not provision of transportation.

Today however, as the foregoing definitions show, the classifications of taxi and limousines have been becoming more broadly defined to include luxury sedans, and SUVs which could conceivably be used either as a taxicab or a limousine – the major

distinction being whether the vehicle had a taxicab meter or not. Some limousine operators, seeking to expand their markets and vehicle utilization in many communities, have expanded their service offerings to include sedan services which have been a major growth opportunity for limousine companies.

This is typical at many airports where limousine companies will offer a flat rate airport limousine (sedan) service to the traveling public. In the vast majority of cases, these flat airport rates will be higher than prevailing taxicab rates, but the difference may be small – less than a 20% premium for luxury sedan service. Alternatively, some taxi operators, using luxury taxicabs (sedans) would like to compete with the traditional limousine market by offering upscale or luxury taxicabs at significantly higher fares than regular taxi service. There is obvious confusion in the marketplace, as essentially the same vehicle is being used for both "on demand" and "contract" service.

When there is a flat rate from the airport and prearranged ground transportation, there is a contract for this service between the passenger and the limousine provider. The rate is typically more than any mandated minimum, so the public's interest is best served by having both services available to the general traveling public. However, it is often tempting for the limousine sedan operator to offer taxi type services elsewhere in the community without a meter or the authority to offer on demand service at rates which may be at or lower than taxicab rates, especially for longer trips, thereby taking a traditional, lucrative passenger market away from taxis.

These movements within the ground transportation industry present significant challenges to local regulators. These authorities seek to protect the general interest of traveling public by enforcing taxi regulations to make this form of common public transportation affordable and available. At the same time, authorities typically favor permitting competition within the traditional limousine (pre-arranged contract) markets to prevail. Regulations are developed to provide a protective zone for short taxi trips thereby preserving the vast majority of these trips for taxicabs. There are two common methods for doing this. The first is to mandate either a fixed waiting time before a contract carrier such as limousines can offer services, usually one hour, but even as much as 24-hours in advance, or secondly, by setting a minimum hourly rate and a minimum of one or two hour contracts for limousines and other prearranged operators, or both.

2.4.4 Short Trip Competitive Advantage

These forms of regulatory rules provide taxis with a competitive economic advantage for shorter trips requiring less time. In addition it is felt that the integrity and availability of taxicabs is maintained. Since limousine services can and do often vary their rates according to demand, (a New Year's Eve rate will be significantly more than the average weekend rate) it would be possible for these carriers to undercut taxi rates during non-peak time periods when demand is lower for a specialized vehicle.

Therefore, local regulatory bodies often face a difficult decision as to how far to separate the taxi industry from competing forms of ground transportation such as limousine sedan services. Setting a minimum limousine rate too high could deprive

the public of this ground transportation alternative, while setting it too low might eliminate the distinction between taxis and limousines. Taxicabs, by regulation, must charge the same metered rate on New Year's Eve as any other night of the year and be available 24 hours per day every day. Thus, the interest of the public is best served by using some regulatory framework that generally encourages short, on-demand, trips to be provided by regulated taxicabs, but provides greater competition among the limousine industry for longer or special event ground transportation trips.

Within Hillsborough County, the PTC has grappled with this issue for many years. A review of PTC meetings ranging back twenty-five years or more indicates considerable thought, reflection, and consultation with both the taxi and limousine operators as to how and at what level to set minimum fares for limousines. For example, in December, 1990, according to the minutes of the PTC Commissioners meeting, they debated the merits of the existing minimum for luxury limousines of $30.00 per hour with a two hour minimum or a $60.00 minimum rate.

Again, in 1991 the PTC minutes reflect, after considerable debate and a full public hearing with members of the limousine and taxi industry testifying, the PTC decided to establish the minimum rate for limousines at $40.00 per hour. The PTC determined this was the best compromise allowing limousine competition among limousine companies but preserving on demand short trips for the taxi industry.

2.6 Glasgow, UK

European regulations, as with their counterparts in the US, originate from the desire to protect the public interest, most specifically the safety of the passenger, and to ensure protection from overcharging. Glasgow, the largest city in Scotland, presents a good example of the types of regulations possible and applied across a number of metropolitan cities in the UK.

Taxi licensing functions are undertaken by the Glasgow City Council, who locate taxi control as a legal function within a licensing department. This is a common approach in UK authority areas, with the exception of Northern Ireland (where taxi licensing is centrally administered at devolved government department level) and has the effect of removing taxi controls from other public transport functions. The city controls license numbers, placing a maximum quantity on the number of taxi licenses that maybe issued at any one time. The city also determines the maximum fares that may be charged - using a cost model based on the measurement of an Industrial Price Index (IPI), see Chapter Four. Quality controls are placed on the mechanical fitness of the taxis in use in the city, with an annual police check and maximum age for vehicles entering service.

Regulations affecting Glasgow are permitted within the meanings of the Civic Government (Scotland) Act, 1982; which permits for the application of a quantity limit, and requires a measurement of tariff levels. The Civic Government Act, along with the Local Government (Miscellaneous Provisions) Act, 1976, which applies to England and Wales, both set out a requirement to control taxi fares and, where quantity limitations are in place, measures to ensure no Significant Unmet Demand

(SUD) exists. The wording of the UK Acts are specific and form the basis of analytical tools in place, discussed in more detail in Chapter Three.

2.7 Belfast, Northern Ireland

Unlike other parts of the UK, which broadly share the same regulations, Northern Ireland taxi services operate under a separate form of taxi regulation, controlled centrally for all Northern Ireland councils by the Department of the Environment for Northern Ireland (DOE). Definitions exist for four forms of taxi, Public Hire (Small Passenger Service Vehicles), Private Hire Taxis (PHVs), Taxibus, and Limousine services (see: DOE, 2006), as set out in Chapter One. Taxi license numbers are not restricted, although distinctions are drawn between public hire taxis that may operate in Belfast, and those that are geographically limited to outside Belfast.

Northern Ireland also provides one of a very few examples of licensed taxibus services in the UK. Traditional London style taxis operate a shared transport service akin to an unscheduled bus operating in multiple occupancy with passengers traveling to differing destinations and charged individually. A more detailed description of Belfast Taxibus services is set out in Chapter nine. A significant history applies to the Belfast Taxibus services, which also demonstrates a measured approach to develop new licensing as appropriate to the forms of transport in use.

2.8 Future Development of Taxi Controls

The deregulation of taxi and limousine services and its probable impact on the public interest has given rise to much discussion. If limousines, especially sedans, are permitted to provide taxi type services with no regulation as to rates and charges, then the taxi industry is effectively deregulated as to entry. Thus, whether one is talking about taxi deregulation or eliminating minimum fares for limousines, the effect is the same.

2.9 Black Car Services

In one U.S. city, New York City, non-metered sedans known as Black Car services are encouraged and regulated as a substitute for their fabled Yellow Taxi services. New York City Yellow taxis, some 12,000 of them, do not have radios and therefore, do not trade in pre-arranged business. Their market is purely walk up or street hail. Taxi medallions in New York City are auctioned off by the City for sums in excess of $500,000. Each taxicab must then be capable of supporting the cost or interest expense associated with buying a medallion with near constant occupancy of the vehicle – people hopping in and out of the cab, being constantly hailed, etc. This is the only way the taxi, being utilized 24 hours per day, can support this level of medallion cost.

Individuals wanting pre-arranged service turn to New York's Black Car industry, which operates much the same as pre-arranged taxi service does in other North American cities. These black cars vastly outnumber the Yellow Taxi Cabs throughout New York City.

One should observe however, that these taxi/limousine conditions exist nowhere else in North America, and that few other cities could adopt their approach to economic regulation of taxis vs. limousines.

Chapter Three: Fundamentals of Taxi Analysis

Introduction

Analysis of taxi markets arises, to a significant extent, from the legislated environment in which services are supplied. Differing forms of analysis can be allied to the specific areas of market control and range from approaches (models) identifying the comparative position of the mode in relation to other forms of transport, to complex models of supply. The complexity of the models reflecting the complexity of controls applied within the markets, which differ from location to location.

A significant element of taxi analysis arises from a need to determine the appropriate numbers of licenses in cities that chose to restrict, but will also extend to the approaches adopted in ensuring vehicles are safe, and in setting the tariffs on the basis of measured cost.

This chapter sets out the main approaches to taxi analysis applied in the UK. A detailed analysis of common approaches used in other countries, including the forms of analysis most common applied in the USA is set out in chapter four.

3.1 Forms of taxi analysis

The application of analysis to taxis relates, as in other forms of transport, to the factors influencing both supply and demand. Analytical models of the taxi market exist and are applied in many countries as a part of a licensing authority's approach to achieving appropriate market conditions. A "taxi model" might thus be defined as a tool applied to determine and influence optimal market conditions, most particularly in relation to optimizing the controls in place designed to control the market including any combinations of Quality, Quantity and Economic (QQE) regulation; but significantly biased, in the UK, toward quantity control.

Common approaches, in the UK, have emerged in the development of supply models; addressing the impacts of changes in supply on the use of, particularly delay in engaging, taxis. A more common method in the USA relates to the use of models of demand, including regression analysis, in determining changes in the overall demand for taxi transport, quantifying changes in "need" (for taxi licenses) on the basis of variation from an identified benchmark. In addition to models addressing the need for greater or lesser numbers of licenses, taxis can also be included in wider traffic based analysis, typically used in determining route choice, and in social and economic models, particularly developed in some Asian countries.

A separate stream of analysis relates to the determination of taxi operating costs, and includes analytical approaches applied to taxi fares (tariffs), including assessments based on a mix of Industrial and Consumer Price

Indices; and analysis applied to the operational aspects of taxi supply including stance design[7] and controls.

3.2 What is a taxi model?

The term "model" relates to any process by which policies are applied to the local provision of taxis. The term is often used to mean two things. Firstly, a description of a set of factors typical in applying a range of controls (a regulatory model); secondly, in referring to an analytical tool used in determining forms of operation. The latter "analytical" model being defined as (Ortuzar and Willumsen, 2004) a "simplified version of a part of the real world", able to… "replicate the system of interest and its behavior". In short, the analytical model allows for testing of a range of scenarios to identify likely changes that would follow.

Whilst this chapter concentrates on the development of the analytical model, it is appropriate to note that the scenarios being considered arise directly from choices between forms of regulation. Table 3.1 outlines the three primary areas of control and associated regulatory and analytical models applying to each.

Table 3.1 Regulatory and analytical models common to taxis

	Quality Control	Quantity Restriction	Economic Regulation

[7] Also known as Taxi Stands, cabstands and taxi ranks.

Regulatory Models	Safety Comfort Appearance	License Numbers / Medallion Caps	Tariff Charges
Analytical Models	Vehicle Testing eg: PSV / MOT[8]	Measurement of (unmet) demand	Cost Models

Both regulatory and analytical models exist across all countries applying taxi controls. The following sections detail the main approaches to taxi modeling, and common approaches to its application in the UK, in this chapter; and the USA, in Chapter Four. Other international approaches are also outlined in Chapter Four.

3.3 Recent developments in taxi analysis

Current trends, identifiable in the UK since bus service deregulation following the Transport Act in 1985, and in the USA following market deregulation and re-regulation of the 1970s and 1980s, have tended to reflect the two alternative choices of regulated market entry, or de-restricted market access. Against this backdrop, taxi models have tended to be used either in support of a particular regulatory position, or in advancing an alterative. In chapter two we introduced the alternative forms of control and regulation commonly applied to the taxi market. In subsequent sections of this chapter we will outline the ways in which taxi models have been applied in their defense. A key element within this discussion is the choice whether or not to deregulate taxi supply.

[8] MOT Tests (Ministry of Transport), properly vehicle compliance testing, are applied in the UK to ensure vehicle standards, to private vehicles. PSV Testing (Public Service Vehicle), and PCV (Passenger Carrying Vehicle) are applied to other vehicle types.

The 1985 Transport Act was introduced, in Great Britain, primarily to deregulate bus services in England and Wales, with similar legislation in Scotland. The Act also allowed for (but did not impose) the opening of taxi markets[9], by allowing licensing authorities the choice to remove quantity restrictions. Uptake appears to have been slow with a further intervention following in 2003 with an Office of Fair Trading (OFT) report (report no. 676 - OFT, 2003), which suggested that restricting market entry did not serve the needs of the public. In its report the OFT concluded that the structures then in place – which allowed for entry restrictions - operated against the public interest and, while the issue of quality may be affected by de-restriction, alternative forms of regulation existed that were more appropriate than the existing forms of control.

Responses to the OFT were notably mixed, while many shared reservations about the market in which taxis were provided and distinct opposition was voiced at many levels, including by the Commons Select Committee on Transport.

The OFT report brought to the fore the ongoing discussions within licensing authorities initiated by the Transport Act 1985. The report also focused attention on the analytical models then applied, the majority of which focused on the specific requirements set out in the Local Government and the Civic Government Acts. The two Acts, which both utilize large sections of identical

[9] In Northern Ireland no similar legislation was applied, with the majority of public transport remaining in the state sector controlled through the Northern Ireland Transport Holding Company, currently trading as translink services.

wording, require authorities that chose to regulate quantity to demonstrate that no significant unmet demand exists – a continuing requirement, and the underlying basis of models of Significant Unmet Demand.

The specific nature of the requirement resulted in a series of analytical approaches seeking to measure for Significant Unmet Demand (SUD). A number of approaches emerged ranging from qualitative consumer surveys, to quantitative measurements – the most common form of approach – the latter being dominant in its use, widespread as a SUD model, and a de facto approach in many UK locations.

While the OFT report (2003) failed to produce a wholesale move to deregulation in the taxi industry, its findings produced a paradigm shift accelerating the move toward deregulation and focusing attention on the effectiveness of the market controls in place. A review by the UK Department for Transport (DfT), a central government department, concluded on best practices applied in the assessment of taxi services, taking up on some of the issues highlighted by the OFT, specifically the need to address peak levels of demand as well as overall levels and the need to consider latent hidden demand previously absent from the SUD model. The DfT reported in 2006 by setting out best practice guidelines (DfT, 2006) applied in England and Wales. The Scottish Government similarly set out best practice for Scotland (Scotland, 2007), following the principles set out in the DfT report. Both DfT and Scottish Government reports highlight the desire to ensure appropriate

supply, and both set out a practical method of analysis where quantity restrictions are in place.

3.4 Taxi Market Models

The taxi market model has emerged as a series of tests specific to the supply of (in the UK) and demand for (in the USA) taxis. Market models can be applied to any of the areas of regulation (QQE), discussed in this section and should arguably work across more than one area of regulatory control (this is discussed in section x.x), while current taxi market models themselves have tended to concentrate on single areas of regulation in isolation.

The following sections set out the areas in which taxi market models are applied, with section 3.5 setting out the detail of the models themselves.

3.4.1 Quality Control

Quality control is an overarching description applied to a variety of factors affecting the quality and safety of taxi vehicles. These include, but are not limited to:

- Vehicle Safety, including PHV testing

- Operator and Driver Fitness
- Comfort, and appearance of licensed taxis

Vehicle safety restrictions

All cities require vehicles to fulfill vehicle safety minima, standards covering the basic road fitness of taxis. The concept and application of vehicle safety standards and associated testing receives little commentary, appears uncontroversial, and is similar across UK authorities to the standard tests set for private cars (MOT test). The main differences relate to the frequency of testing, taxis are generally required to complete testing once a year from the date of first registration, as opposed to testing from the third year applied to private cars. In a limited number of locations older vehicles are required to be tested more often, while some authorities apply an upper age limit, as a form of vehicle type restriction.

Operator and driver fitness

Operator and driver may also be included under 'regulation' both being subject to objective testing and may require a greater level of competence than required to drive privately. This can include additional driver testing, a good example of which is the London taxi "knowledge" test, and additional standards applied to operator premises. The concepts are not as widely applied

as the roadworthiness tests, which are universally applied in the UK, and have courted some controversy in instances where their application has been suggested (DOE, 2007). Opponents of additional testing tend to oppose on the grounds of additional cost but may also identify new testing as a threat or form of 'hidden' discrimination, or hidden barrier to entry.

Vehicle type requirements

The specification of vehicle type requirements can also be seen as a quality control with current controls applying variously, to basic appearance, vehicle color, signage etc., to specific vehicle models or requirements to supply wheelchair accessible vehicles (see: DfT, 2009). A number of standards exist in the UK, of which the Metropolitan Conditions of Fitness (MCF) has become the most commonly applied, this tending to be a de-facto standard in larger metropolitan cities. The MCF conditions have a significant history, as detailed in chapter one, and were initially applied to London taxis in 1906. The conditions allow for determination of a particular vehicle standard.

Most vehicle type restrictions, including the MCF, are not mandated on the basis of national legislation, but rather on the desire of a local licensing authority to ensure a standard of vehicle operating in the taxi parc[10]. The MCF originate and continue to be applied as a standard for London "black" taxis (Hackney Carriages), and specify very strict operating parameters for vehicles

[10] The Taxi "parc" relates to the fleet available for service

including cabin space and turning circle requirement. Cities choosing to apply MCF requirements may often do so to ensure a premium fleet.

MCF requirements, however, do court controversy in two areas, in relation to their limiting vehicle choices and in relation to a turning circle requirement included in the standard. In practice, only two types of vehicle fully comply with the MCF requirements, the Metrocab, and vehicles produced by London Taxis International – currently the TX1, TX2 and TX4. In practice many cities purporting to follow, or reported as following, MCF do not apply turning circle requirements. This is illustrated by Glasgow which allows a number of other black taxi styled vehicles that conform to the majority of the MCF requirements but fail the turning circle; these include the E7 Eurotaxi, and TW200, both being popular (and cheaper) taxi vehicles. Other instances of restriction include cities allowing fleets of vehicles to a specific age, and in some instances authorities insisting on greater numbers of roadworthiness checks on older vehicles (see South Ayrshire, 2006).

An exception to locally applied vehicle standards include regulations designed to benefit specific vulnerable groups including those with physical disability. National legislation includes, in the UK, the Disability Discrimination Act, 1995 (DDA), and the Americans with Disabilities Act (ADA) in the USA. Both are national, the DDA covering England, Wales, Northern Ireland and Scotland and the ADA being a federal law in the USA. Both seek to address the needs of wheelchair users and other ambulant disabilities but have significantly different approaches. The primary difference between the

approaches in the USA and UK relates to the form of transport that is mandated, the DDA in the UK requiring where applied, accommodation within the existing taxi fleet for wheelchair carriage; the ADA, in the USA requiring separate but parallel door-to-door provision.

Not all locations apply DDA requirements, while the legislation neither specifies the types of vehicles required for carriage of wheelchairs (11), nor that all authorities should apply the requirement. A number seek exemption, allowed under Chapter 50, Section 35 of the DDA to avoid its application. The apparent loophole exists for smaller authorities and where application would create negative market conditions adversely affecting supply.

Vehicle appearance restrictions

In addition to the types of vehicles permitted, some Licensing Authorities choose to specify appearance requirements, including bodywork color (eg: St Albans), and in some instances restrictions on the extent of advertising and signage permitted (eg: Highlands). As the restriction is applied globally within the authority areas, it attracts little controversy, except in instances where its application is considered to be inconsistent or discriminatory. Examples of controversial sign restrictions include moves to remove roof top signage from PHVs in Northern Ireland (DOE, 2002), a move successfully applied to London PHV taxis in 2000.

[11] At the time of writing no specification of an accessible vehicle has been determined.

While quality controls remain the least controversial area of taxi regulation, it can be easily seen that any such restrictions can, and do, impact on the wider market in which taxis are supplied. The majority of modeling approaches in contrast treat the issues of vehicle quality controls in isolation from other regulatory analysis.

3.4.2 Quantity Controls

By far the most controversial element of taxi regulation is that of quantity control. This can include restrictions applied to the numbers of vehicles and licenses issued in a Licensing Authority area. The most common form of control is a direct limit to the numbers of vehicles permitted to operate, usually achieved by placing an upper limit (cap) on the numbers of licenses issued, affecting and restricting supply. The issue of quantity control relates directly to the long-standing argument as to whether markets perform better under controlled competition (regulation) or de-restriction.

Properly speaking supply restrictions can be identified as barriers to market entry. However, the policy of restricting license numbers differs significantly from fitness for purpose requirements identified as a quality control. Furthermore, the tests applied to restricted licenses recur, are mandated, and subject to testing on a regular basis as a result of case law (see: Coyle v City

of Glasgow: Sheriffs Court, 1998), whereas limits on fitness for purpose tend to stand as long running and generally uncontroversial. Such tests, in the UK, form the basis of the most common form of taxi model, the SUD model or survey for significant levels of unmet demand.

The policy of restricting entry is highly controversial and is limited in the UK to where an authority is able to demonstrate that no negative impacts will result as a result of the policy. This is effectively construed to mean no SUD. The approach mirrors similar concepts previously adopted in New Zealand which has since deregulated supply (Transport Services Licensing Act 1989).

Unmet Demand

The most common form of taxi analysis in the UK relates to the measurement of demand, specifically the presence (or absence) of SUD. As many cities in the UK continue to apply restrictions to the numbers of licenses SUD testing is widely used. Analysis has developed around an observation survey and tends to follow a similar pattern across authority areas. Such 'standardization' is widespread and follows legislated requirements set out in the Civic and Local Government Acts. Taxi quantity modeling has, as a result, become heavily weighted toward a standard approach, a de facto form of model,which is detailed in section X. The standard model can, however, only provide detailed assessment for some of the elements pertinent to supply restriction and suffers, in some instances, as a result of limited scope and limited application.

Latent Demand

The extent of analysis concentrated on determining SUD in the UK has led to a number of reviews of the modeling itself. Amongst these, the Department for Transport reported in 2006 (DfT, 2006) on approaches to extend the assessment process. The issues of hidden demand (latent demand) had been largely absent from previous analysis, which concentrated on the revealed delays experienced at taxi stance (patent demand). Latent demand is defined as relating to the numbers of intending passengers choosing not to travel, for example as a result of perceived (and actual) delay; and journeys that would be further created as a result of changes to the supply of taxis. The same report also identified an issue in the measurement of peaked demand which is set out below.

Peaked Demand

DfT Best Practice Guidance (DfT, 2006) underlines the significance of measuring latent demand in respect of taxi supply but further outlined a need to consider the nature of taxi demand peaking. The market for taxis in many urban areas differs from more traditional transport modes and includes notable peaks in demand at night-time and at weekends in points of time where traditional transport modes are not available or operate a reduced service.

Weekend night times tend to be the highest points in demand for taxi use with many cities seeing a dominance of taxis in the nighttime market. The night time peak is difficult to accommodate well within the overall patterns of taxi supply, as the numbers of vehicles within a fleet reflect both a day and night time equilibrium. Increased numbers of vehicles within a fleet sufficient to a nighttime peak may also result in a glut of supply during the day. The DfT guidance (DfT, 2006) highlighted the need to consider peaks in supply but did not set out methods by which this might be achieved.

3.4.3 Economic regulation

The third element in taxi regulation, economic control, owes much of its development to a political desire to avoid overcharging, and is mainly visible as controls to tariffs applied to taxi fares. In this respect the term applied to the control of economic aspects of taxis should be clarified and applied in the determination of price restriction and appropriate tariffs alone.

Limits to the level of charges that may be made for using a taxi are determined locally by each of the licensing authorities in the UK. Authorities determine charges possible in the form of a tariff table usually, but not always, defining time, distance and engagement charges, used in combination to produce a fare. The application of price controls is justified in most instances as a balanced measure against overcharging by unscrupulous drivers and included in leading

legislation as a requirement to review (but not necessarily amend) tariffs on a regular basis. As with quantity control the requirement in law to review tariffs is likely to have contributed to the development of a series of common analytical approaches (cost models) but, unlike quantity controls, such approaches do not represent a single standard model, but rather a series of concepts appropriate in the determination of fare increase.

Taxi Cost Models

Unlike quantity control, a single standard taxi cost model has not been developed to the same extent as for taxi demand. Common approaches however, do exist and are visible as common concepts, primarily statistical methods applied to determining operating costs – cost models.

The absolute cost of operating a taxi (the production cost) relates to the summation of all units of operating cost, both fixed and variable, with an additional element associated with an desirable level of income (wage) paid to the driver. The wage element being effectively the difference between income taken from passengers (fare box) minus production costs. All authorities in UK are required (under the Local Government and Civic Government Acts) to undertake a regular fare review, with many seeking to identify changes to key costs, rather than a full analysis of all costs of all vehicles. Three distinct steps are observed; the identification of production costs, metrics against which

operating costs are measured, sometimes referred to as the cost model; the collection and collation of data and statistics, intended to populate the cost model; and the application of any observed increases in operating costs, arising from the cost model, to the tariff itself.

A number of issues exist in the application of the cost model, not least the variability of costs dependant on individual driver, vehicle and road standards, which have led (in all authorities surveyed) to the use of typical vehicle and typical operating circumstances. Thus, a typical value is given for vehicle costs, fuel consumption, maintenance requirements and mileage. Year on year changes in typical costs may also be used to provide indicative relative changes in the costs of production, these forming the basis for increases in tariff. The measurement of an absolute cost for every vehicle is unlikely to be practical, or indeed sensible as the extent of changes from year to year would lead to wildly varying costs.

While each of the regulatory areas and their associated modeling tools can be approached in isolation, each area generally being assessed without reference to the others, distinct and logical links exist between each. The following section explores the nature of the analytical models and tools used in each of the areas of regulation and continues to explore the nature and inclusion of links between them.

3.5 Current Models

At the outset of this chapter we identified two forms of model, regulatory models of supply, and analytical models – tools specific to determining and informing choices in regulation. This section discusses analytical models commonly applied in the taxi industry. The section outlines similarities and differences between models applied in the UK, and those used elsewhere. Detailed commentary of worldwide models is set out in chapter four.

3.5.1 Quantity Models, satisfying demand

The SUD model is the most commonly and consistently defined approach to taxi analysis in the UK. The model is commonly applied in response to legislated requirements where a need to test for unmet demand is specified.

(Insert Image: Figure 3.1)

Figure 3.1 SUD Model[12]

Figure 3.1 (above) sets out the basic elements of a "standard" SUD model, the centerpiece of which is the determination of an index of SUD (ISUD). The model is split into three main processes, an initial trawl of current market conditions, measurement of ISUD, and a fleet impact model based on the response to changes in fleet size. The former relating to observations of the performance of the market under typical current conditions, the latter to a (modeled) response to changes in fleet size. The details of each element are set out below.

Initial Trawl

The first step within the process is an initial observation of current market conditions. The trawl provides a rudimentary observation suggesting possibility and probability of SUD. Outcomes are defined as "Possibly / Probably SUD" and "Not a SUD", the latter being a conclusion where delays are identified only during a peak in a highly peaked location. As in other forms of transport, peaked demand relates to the extent to which demand is increased at specific times of day, with peaks in demand for taxis occurring most often at night and most distinctly at weekend night times.

[12] See Cooper, 2007

The extent of certainty possible within this trawl is limited and requires observation of peaking patterns and a determination as to what defines "highly peaked". The approach is further challenged by departmental best practice guidance (DfT, 2006), indicating a need within modeling to take full account of demand at all times (including peaks), effectively removing the conclusion of "Not a SUD" at this point. A review of current responses to emerging best practice guidance is set out below.

As most reviews appear to suggest at least a possibility of SUD most, if not all, continue to undertake further analysis. This may also reflect the desire of study managers to deliver a conclusive report.

ISUD Model

ISUD represents a consistent measure of unmet demand based on observation of delay. The measure provides a direct comparison between locations, which has been used to establish an approximate ISUD value at which unmet demand may be said to be significant, and a benchmark against which changes in fleet size may be tested.

The calculation of ISUD is based on the formula:

ISUD = APD x ED x P1 x HP

Where:

APD = Average passenger delay across all time periods

ED = Excess demand during the Monday to Friday daytime period

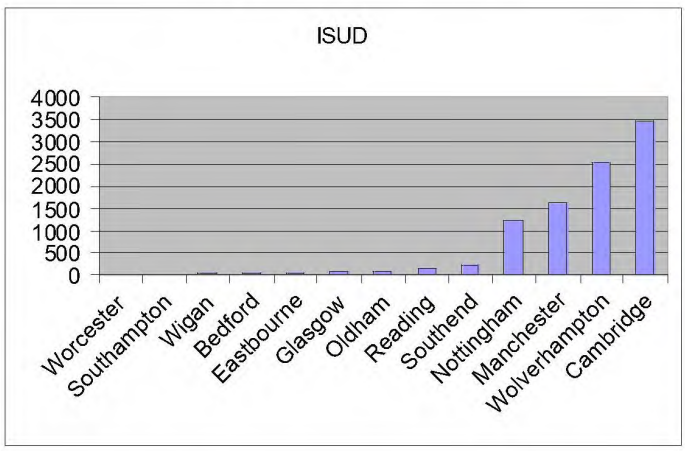
P1 = The proportion of taxi users traveling in hours where the overall average delay at the stance was greater than or equal to one minute

HP = Adjustment factor where peaking is present (1 if no peaking, 0.5 in instances of peaked demand).

The ISUD model benefits from a consistency in methodological approach, reducing the potential for interpretive errors, and thus appears stronger in its results when compared to the initial trawl. Its calculation is logical, and, given its purpose of comparing the performance of one city against experience in another, useful. Resulting values (ISUD = x) provider a comparator of the effectiveness of supply in one location when compared to others.

A nominal value is common (ISUD = 80) and is used as a threshold between unmet demand and significant unmet demand derived from previous studies as indicative of ISUD values in locations where unmet demand has been felt not to be significant, but the definition of the value remains arbitrary. Figure 3.2, below, shows the extent of variation between ISUD values in UK cities in the period to 2006.

Figure 3.2 Comparative ISUD values



Source: completed SUD models

The extent of variation between UK cities, as indicated in figure 3.2, demonstrates the significant differences between locations, but should also indicate a need for caution in the interpretation of these results in identifying an absolute level at which Significant Unmet Demand is identified. Issues also arise in the determination of a single threshold for delay since the expectations of waiting time varying between time periods and forms of taxi use.

Subsequent elements of the SUD model, the fleet impact model, are based on the legislated requirement to ensure no Significant Unmet Demand exists. In instances where ISUD is greater than the threshold (ISUD = 80) it is common

for an authority to predict the impacts arising from an increased number of taxis operating within the fleet on the ISUD value measured. Where this can be shown within the model to reduce the ISUD value to below the threshold, the legislated requirement can be said to have been achieved with licensing authorities increasing numbers of licenses available to achieve this shift. The methods of determining impacts of changes to license numbers are included in the Fleet Impact Model, described below.

Fleet Impact Model

The third element within the SUD model develops scenarios for testing in instances where ISUD values exceed a "significance" threshold as detailed in previous sections. In such instances an authority has not been able to demonstrate a lack of Significant Unmet Demand and must adopt one of two options, the removal of quantity restriction, or the adoption of new practices, mainly based on issuing new licenses.

3.5.1.1 Applications of taxi quantity models

The SUD model, and derivatives thereof, is widely applied in the UK in response to legislated licensing requirements. The model determines a measured comparative position of a city in respect to unmet demand and

offers a method by which the impacts of changes in fleet numbers may be tested.

Licensing Solutions

Application of the SUD model has developed over time to include the addition of a fleet impact analysis, shown in Figure 3.1 as a Fleet Impact Model, from which an authority is able to determine the reductions in measured SUD (ISUD) resulting from an increased number of taxi licenses. The authority is able in this way to determine the numbers of additional licenses required to conform to the legislated requirement that no SUD is present.

The approach of issuing new licenses to reduce ISUD is common and can be effective where a lack of supply results from an insufficiently large fleet. It may be suggested, however, that high levels of ISUD may result from a variety of causes, not limited to an insufficient absolute number of licenses. Wider causes may include the performance of particular taxi stances, for example where access or egress are limited, or from the structure of the market itself, whether concentrated on taxi rank markets or dispatch; or in instances where demand concentrates on specific peaks or on individual stances, as might occur in peaked demand for travel home from night time entertainment.

Regression based solutions

Although technically allied to the issuance of new licenses, the use of regression analysis is popular in the USA and provides an alternative to the observation based ISUD approach in the UK. A detailed review of the technique is set out in Schaller (2005), and reported in chapter four.

Non-Licensing Solutions

In its current application the "licensing solution", set out above, considers solutions to significant unmet demand as related purely to an increase in the numbers of licenses issued. The desire to reduce SUD, however, may also be achieved through other measures increasing utilization of the fleet with the same result.

Alternative approaches impacting on the supply of taxis at peak times may in reality, provide a better solution to reducing ISUD insofar as targeted peak improvements, or wider access improvements such as better stance engineering, may provide a positive impact at points in peak demand without resulting in excess supply during off peak periods.

A complementary Non Licensing sub model (NLSM) has been developed and applied in some UK cities. The NLSM approach works within the same framework as for previous ISUD analysis, see figure 3.3, but extends modeling to include an assessment of the alternatives to license issuance including stance engineering enhancement. Despite considerable differences

in the design and use of differing stances in any city, most SUD models have tended to treat each the same, all having unlimited capacity and all functioning without physical restrictions of constraint. In reality each presents unique operational issues, while achieving an improvement at one stance will have knock-on effects across a location. The identification of a Taxi at stance model, set out in the next section, allows for a more detailed analysis of the impacts of changes to stance at any individual location.

(Insert Image: Figure 3.3)

Figure 3.3 Quantity Modeling including NLSM approach

3.5.2 Taxi at Stance models

Although sharing many characteristics with the taxi quantity models, defined above a number of separate and distinct approaches exist in the analysis of taxi behavior at stance. The following section describes a number of analytical approaches that have been applied to taxi stance design and use. These range from qualitative models providing a basic approach to facilities at stance, to more complex analysis of impacts of changes to stance design, including those fitting directly into the NLSM model described in section 3.5.1.1, above.

Qualitative Analysis applied at stance

A framework for analysis of taxi stances emerges from work undertaken by Transport for London in 2003 (TfL, 2003 p23). The London study included the development of a qualitative assessment framework, illustrated in figure 3.4. below, allowing for scoring across a number of key elements in stance design.

Figure 3.4: Qualitative framework for scoring stance facilities

Indicator	Score
SET DOWN AREA	
Walking distance to facilities from set down point	
Degree of comfort in set down	
Efficiency in set down	
Ease of taxis progressing to pick up	
Carriageway markings	
TAXI STANCE	
Relationship with set down facilities	
Interference from pedestrians	
Capacity of stance	
Carriageway markings and signs for drivers	
PICK UP AREA	
Waiting time	
Accessibility for the mobility impaired	
Efficiency of the passenger queue	
Facilities provided at stance	
Degree of comfort in queue	
Capacity of passenger queue	
Adequacy of loading bays	
Speed of taxis exiting loading area	
Accessibility of exit to highway	

Derived from TfL (2003)

The TfL framework identifies a wide range of issues that may limit the performance of a stance, and allows for a qualitative score, used in the TfL analysis to prioritize stance improvement. The framework may also be used to inform more detailed analysis at stance, including that set out below.

Quantitative Analysis at stance

Further approaches may also be identified in relation to stance design and performance and in relation to the optimal location of taxi stance locations. These represent the (differing) desires to site stances at optimal locations, and to ensure that performance, in terms of vehicle and passenger throughput is maximized.

Stance performance

The ability of a stance to operate well reflects a wide range of factors, many of which contribute to delays in accessing the rank, for example where a vehicle is delayed in entering a stance area, or delays resulting in slow loading times or difficulty in exiting back on to public highway. Reductions in any of the factors creating a delay at stance will have a direct effect on the performance of that stance and will further contribute to the numbers of available vehicles operating across a wider area. Previous sections have detailed the potential for a non-licensing solution to a lack of appropriate supply. The improvement of

performance at individual stances contributes to this and is defined here as Time Savings at Stance (TSAS), integrated into the model defined in section 3.5.1.1.

Time Savings at Stance Model (TSAS)

This model identifies the impacts of changes in stance specific factors on supply at those stances as a time saving at stance, on the same basis as time savings shown in the licensing solutions approach. Each change in infrastructure materially changes stance performance and is identified as a new (or further) calculation of savings, with total savings cumulative of all changes made at stance. Using traditional notation the initial calculation is defined as:

TSAS = (CAD – TSE)

Where:

TSAS = Time Savings at Stance per vehicle

CAD = Current arrival delay

TSE = Vehicle Time savings resulting from change

As a vehicle arrives and departs more quickly from the stance, users of the stance experience a time benefit. Benefits also accrue to the wider fleet. Time savings at stance run parallel in the model to extra arrivals in the SUD model

and can be input in subsequent stages where time savings are converted into extra arrivals, using an approach similar to the existing Extra Arrivals (EA) determination contained in the standard approach. A conversion to extra arrivals (CEA) is applied according to the formula:

CEA = ((TP/(AJT-TSAS)) x NVF) – ((TP / AJT) x NVF)

Where:

TP = Time period

AJT = Average journey time

TSAS = Time Savings at Stance

NVF = Number of vehicles in fleet

Results of the conversion to extra arrivals (CEA) provides an output in the same format as the original standard model, and can be further analyzed using the same Impact of Additional Arrivals (IAA) sub-model as included in the original approach. However, as the fleet size is not affected by the improvements at stance, merely their efficiencies, it is not necessary to continue to apply the Impacts of Larger Fleet (ILF) sub-model at this stage. Results from the new NLSM model are presented in the same format as those calculated in the original FISM model, and allow for conclusions to be drawn on the same basis as before.

The effect of reducing time delays is illustrated, in figure 3.5, in relation to a taxi stance in Glasgow, Scotland, that would result from the simple measure of allowing pick-ups from both sides of the street.

3.5.2.1 Case Study: stance engineering improvements in Glasgow

Glasgow is Scotland's second, and largest, city. The city has a wide range of activities and has a significant and widely recognized nighttime economy. A significant concentration of activities occur around Buchanan Street, George Square and Sauchihall Street in the city, with a high level of demand for taxis at the centrally located Gordon Street taxi stance, which also serves Central Station, one of the city's two main railway termini.

An analysis of the operation of the Gordon Street taxi stance, completed in 2003 on behalf of the local taxi supplier, Glasgow Taxis, revealed a number of operating issues at the stance, related to access and egress, and to pedestrian behavior at the stance at peak times. Operating patterns were significantly hampered by two factors, delays in passengers accessing vehicles when crossing the road, impacting on the stance departure time, and a need for Westbound traffic to divert, departing East around a one way system rather than depart in a westerly direction, see figure 3.5. Passengers seeking to travel West and North were required to divert in their journey to the East, travel from the Gordon Street stance to the West and North encountering an additional 439 metres (measured at centre line) as a result of the directional nature of the

stance. Where this diversion is followed journey time within the fleet is increased and passengers experience higher fares than strictly appropriate to their journey.

Figure 3.5 Gordon Street stance, Glasgow, Scotland

(Insert Image: Figure 3.5)

Existing taxi stance facilities were located on the northern pavement suitable for vehicles travelling East and South, but extending journeys for those travelling West and South. An additional conflict existed as intending taxi passengers arriving at Glasgow Central Station, located on the southern pavement, were put into conflict as they had to cross the road to access the taxi stance. Pedestrian controlled crossing points do exist at each end of Gordon Street but a significant number of intending taxi passengers were observed as crossing between these points to avoid the additional walking.

The eastbound departures also required a diversion for passengers intending to travel west and north, shown in red in figure 3.5. Where this diversion is followed both journey time and tariff charged increase to the passenger whilst the effective availability of the fleet falls in proportion to the lost mileage. Realignment of the stance would, where implemented to allow for departures from both sides of the road, eliminate the need to divert to the East, and create a significant time saving at this stance.

An engineering scenario was developed in which an additional stance was developed on the southern pavement in Gordon Street to facilitate westbound departures by reducing the extent of diversion and effectively increasing supply as time taken in travel is reduced. The resulting time saving (input as TSE in the time savings at stance approach described above) reduces the time a vehicle is occupied with the wider benefit of the same vehicle returning to the available fleet more quickly.

In the Glasgow example realignment of the stance allows for departures from both sides of the road, eliminates the need to divert to the East, and create a significant time saving at this stance. Calculation of TSE in this instance is based on the formula:

TSE = (AJT – TS)PWD

Where:

TSE = Vehicle Time savings resulting from change

AJT = Average Journey Time

PWD = Proportion of Westbound Departures

The application of the time saving per vehicle at one stance will in turn impact on the supply of taxis across the wider fleet producing, in this instance, a time-saving of 0.67 minutes per vehicle movement applied across the entire fleet. A conversion factor CEA, detailed above, applies the timesaving to the original

SUD model to result in a consistent measure using ISUD values as applied in previous analysis.

Benefits may arise in improving stance engineering as an alternative to license issuance where significant peaks exist not well served by an existing fleet and in particular in instances where off peak taxi supply exceeds demand.

Other examples of individual stance improvements leading to a reduction in ISUD may include the use of taxi marshals, taxi company and/or authority officers at stance directing pick-ups and departures. The use of marshals has increased in cities in the UK, in particular at stances with heavy nighttime demand; with UK experience mirroring the time savings observed with the introduction of curbside dispatch of taxis at airports in the USA.

3.5.2.2 Taxi Stance Location Models

In addition to analysis that considers the performance of stances under current conditions, being the consideration of potential improvements at existing stances, it may also be appropriate to look at their actual location.

The demand on a stance varies by time of day with the needs of a daytime population differing from those at night. This may in part arise from the purpose of the journey being made, but may also arise from the physical location of activities resulting in taxi use. It is also noted that the use of

stances, as opposed to street hail or dispatched journeys, differs from location to location, and will often reflect a predominance and preference for one form of engagement over another.

Facilities provided at a stance are also significant and arise from the location of the stance, and its primary markets. In this respect it is possible to identify a need for information provision, particularly at locations serving at an interchange between forms of transport. Further consideration regarding stance design may extend to the consideration of accessibility at stance, the need for a pavement design to accommodate loading and unloading of wheelchairs, and the related issues of cost, which may be high when considered against likely use. Cost considerations also impact on the location and construction of new stances, particularly where alternative uses may raise revenue for an authority, such as parking bays.

Main approaches to taxi stance locations

There are no specific models that address taxi stance location in isolation, though a number of approaches do exist and are included in wider analysis of taxi demand. Lang et al (2000) devise a macroscopic model of taxi demand that includes an average passenger waiting time equation, at stance, based on queuing theory. The Lang design, developed from observations in Hong Kong, couples endogenous and exogenous variables to achieve an optimal level of supply throughout the system. The calculation includes, but is not limited to

the engagement of taxis at stance and as such does not provide for a single stance analysis based on a "what-if" scenario, but rather the impacts of changes in total supply of taxis on the waiting times at a stance.

The Lang model does, however, correlate with the SUD approaches in the UK on the use of a waiting time variable in the analysis of stance performance. The Lang average passenger waiting time equation, set out below, is significantly more complex than that applied in the SUD analysis, resulting in an estimation of passenger waiting time at a particular taxi stand derived from queuing theory, by assuming that arrival rate is proportional to the number of passengers (Dp) or average number of passengers per licensed taxi (Dp/Nt), and service rate proportional to the inverse of vacant taxi headway (1/Hv) or approximately (1 – U)N.

$$\frac{1}{W_p} = 1.0181 \times 10^{-3}(1 - U_t)N_t - 0.0218\left(\frac{D_p}{N_t}\right)$$

The view that reduction in waiting time, which prevails in both UK and Hong Kong approaches, is significant to the analysis of taxi stances, is significant n the development of a more stance specific approach. Time waited, or more specifically the effective reduction in total travel times including engagement of a taxi may be considered in relation to the development of the stance model itself. Time cost, and the allied calculation of generalized costs, contribute to the analysis of stance location, and may be included in the analysis of stance performance.

The Hong Kong model, defined above, provides a logical macroscopic view of stance provision but does not address the issues of demand on a microscopic level, failing to address stance design or other factors affecting throughput, a similar failing to that observed in the ISUD models applied to demand, nor considering the impacts of cost (generalized cost) on demand.

Generalized cost approaches

The calculation of a generalized cost is based on the monetary and non-monetary costs of a journey. It is a summation of all identifiable and measurable elements to provide a total and comparable cost between journeys of differing times and fare / cost.

In a basic form, generalized cost (gc) is composed of the following:

$$gc = p + u$$

where:

p = monetary costs of the journey.

u = non-monetary (time) costs of an uncongested journey.

A number of texts provide a detailed review of the calculation of generalized costs (see: Jansson and Mortazavi, 2000), with a series of papers applying the principal to forms of public transport (see: Phani Kumar et al, 2004).

Achieving a reduction in travel times, as may result from a reduction in the waiting times at existing stances, or a reduction in the walking times to arrive at a newly located stance provides a measurable generalized cost reduction, the optimization of which informs both stance design, which affects throughput, and stance location.

It is important to add two additional factors that will affect the use of a generalized cost approach in locating and optimizing stance design and location. These relate to a difference in the values associated with time by use (and thus by time of day / activity), and the fact that stances may actually serve a variety of origins, the optimal location reflecting a Pareto optimizing location, the location in which the maximum benefits are achieved to all users without resulting in a loss of benefit to any. A good description of the concepts of Pareto Optima are set out in Acocella and Jones textbook, "The foundations of economic policy" (1998). Hensher (1977) provides a discussion of the values of time associated with travel.

Development of a mesoscopic and microscopic stance location model

An alternative to the macroscopic models builds on the concepts of overall demand at stance and costs of access. The analysis is informed by macro level assessment (to what extent a location performs well against comparable towns) but continues to determine gaps in stance supply and optimal locations.

Gaps analysis is based on calculation of proximity to facilities, using time contour calculations – a surrogate for access cost, which may be further defined by user group. The model determines current rank locations from physical survey, to indicate location against traffic generators including shopping, pubs, and clubs.

Gaps are illustrated in terms of proximity measure (generalized cost) with the potential locations for stand development illustrated, see figure 3.6. The basic calculation arises by identifying the greatest benefit from stand development, calculated as the rank location with the lowest total generalized costs of access.

Figure 3.6 Gaps in stand provision

(Insert Image: Figure 3.6)

Calculation at microscopic level selects within identified gaps, seen on the diagram as yellow circles, those locations offering the greatest overall benefits, those with the highest net present value, using a traditional form of social cost benefit analysis and identifying reductions in access times as benefits by user group and market segment. The approach also benefits in that

it allows for lost revenues, for example where a taxi stance replaces paid for parking bays, to be included as a cost.

3.5.3 Analysis across regulatory domains

Despite the presence of a number of widely applied analytical models, including those seen as de facto industry standards, few fully address the market for taxi services across all of its regulatory domains (QQE).

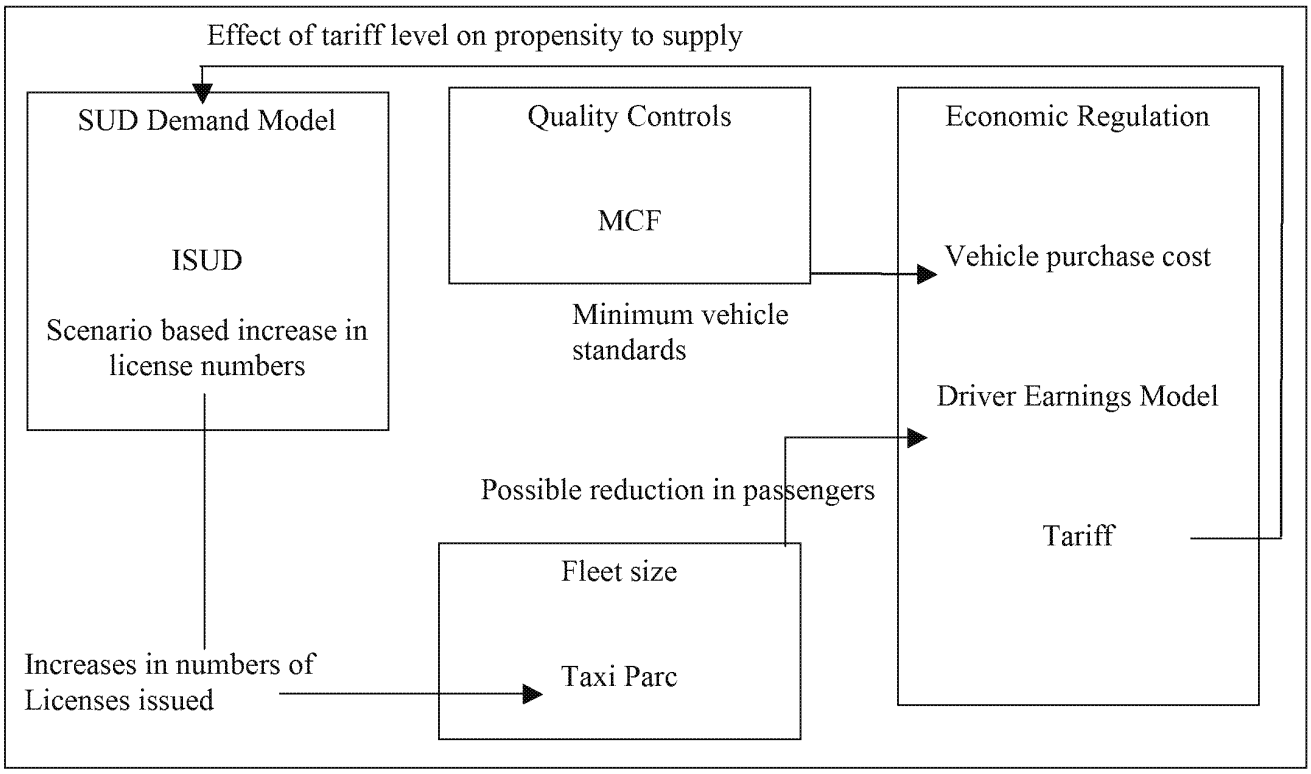
The development of a more comprehensive approach to taxi analysis is significant at a number of levels, not least that the majority of existing models have developed as a result of legislated requirement in support of a particular position, regulated or deregulated taxi supply. It is in this respect significant to note that quantity modeling and demand models do not in themselves solve the dispute or support one form of control over another. The SUD model reports on levels of unmet demand and could equally be applied to controlled and open market conditions. The latter, however, is less frequently undertaken given the legislated role of the model in the former.

The SUD model is not without critique. Two primary issues are common, the extent and nature of assumed behavior within the model, and the common treatment of time and location issues as a single uniform pattern.

Assumptions are apparent in the majority of studies using the model specific to common patterns of stance behavior, including assumptions of unlimited stance capacity and stochastic arrival patterns. Behavioral aspects may also tend to be played down, with few locations undertaking detailed analysis of the desires of a driver to supply services, despite anecdotal evidence suggesting satisficing (the instance where drivers will operate vehicles only until a desired level of income has been achieved). Such behavior will, in reality, result in reducing levels of supply later into shifts, where satisficing occurs over a 24 hour period; and reducing supply toward the end of the month where it occurs in respect of monthly income. Temporal and spatial differences are also limited in the SUD model, this despite a significant body of evidence suggesting widely varying uses of taxis by location and a particular role of the taxi in the night time economy.

Further issues may also relate to the treatment of Quantity in isolation. Changes in fleet size, a potential and likely outcome of the SUD model, are likely to impact directly on a number of other regulatory elements subject to (separate) analysis, see figure 3.6. Thus as the size of the fleet changes so do the potential earnings for taxi drivers which, although separate and not a primary interest of the SUD model, will continue to affect the market for taxi supply beyond that anticipated in the SUD model itself. A review of cost models is set out in section 3.6, below.

Figure 3.6 Interaction between quantity and other regulatory elements



Discussion of the wider links between taxi models, and the potential benefits arising from their combination is set out in section 3.8.

3.6 Economic Regulation: Taxi Cost Models

In addition to controls applied to license numbers and associated analysis of the impacts of changing fleet sizes, a significant body of work exists in relation to economic controls applied to the mode (Schaller cite).

Economic regulation exists and is applied (in a large number of cities) to the levels of fares that may be charged. As with Quantity Models (discussed in section 3.5) taxi cost models have tended to be treated in isolation, despite the existence of linkages as suggested in figure 3.6. This section sets out the most common approaches to taxi cost modeling as applied in the UK, and continues to comment on the relationship between cost and supply.

3.6.1 Defining the taxi tariff

The taxi tariff is the basis on which a taxi fare is determined. Its construction and content vary by location. This said, a number of commonly occurring features do exist in the majority of locations.

A taxi tariff, often presented in the form of a table, is the basis of charging from which taxi fares are derived. The vast majority of Hackney Carriage operations are based on distance travelled or a combination of time and distance. Kilometric pricing, or fare based on miles travelled, is translated into fares by multiplication of distance by rate. Changes to the underlying tariff table have a direct impact on the fares paid, the tariff calculations providing for consistency between journeys and an element of regulatory control that customers are treated fairly and without bias.

A major exception to the time and distance approach can be seen in Washington (DC), in the USA, where fares paid are based on numbers of

zones passed through, and do not have a direct correlation to time or distance. Other exceptions may include airports applying a flat rate fare to a downtown location, or to the use of minimum fares, although the latter – minimum fares – is similar to "flag fall" charges that can be applied in the standard tariff table approaches, the airport minimum charge differing in level rather than concept from the flag fall charge.

A detailed review of the methods by which taxi tariffs are translated into fares is set out in chapter four, see section 4.1.2, below. The subsequent sections in this chapter addresses the methods by which the underlying tariffs are updated.

3.6.2 Tariff Models

The taxi tariff relates to the structure against which fares are calculated. Tariffs are most often determined in relation to the operating costs of a taxi and applied on the basis of time and distance to provide a consistent fare. Analytical approaches exist to identify levels of and changes in the costs associated with the provision of taxis and are applied to determine changes in levels of fares payable. The method, which is properly defined as an Industrial Price Index (IPI), has an established base in many UK cities though the actual content, i.e. the choice of industrial costs to be included, may differ. The approach contrasts starkly with that adopted in the USA, see chapter four, where a much greater emphasis is paced on the comparison of fares in one

jurisdiction with another (increases in line with those adopted in neighboring authorities) or a more simplistic measurement of Consumer Prices (CPI).

The structure for tariff cost models in the UK is largely formalized and predicated, as with quantity analysis, on a legislated requirement to undertake regular reviews. Unlike quantity models however, no single dominant analytical approach exists, the majority of authorities in the UK seeking to establish changes across a variety of productions costs, the nature of which may differ by location.

Figure 3.7 illustrates a "typical" approach outlining the most common IPI measures used in the UK. The summation of production costs identified by location, and most specifically the changes in these costs between reviews, is the most common method for determining cost increases to be applied to the tariff.

(Insert Image: Figure 3.7)
Figure 3.7 Typical models for determining cost

While the choice of costs to be included in the analysis may differ from location to location, the common approach is the summation of production costs to identify changes from time period x to time period y and forms the basis of the majority of such approaches in the UK.

3.6.2.1 Application of measured change to tariff

Despite some differences in measures chosen between locations, the vast majority of analyses result in an indication of the changes in production costs. These provide a current indication of production costs but do not, in themselves, result in a change to the fares paid by customers. Any change requires a further two step process:

- Transfer to tariff increase, and
- Application to tariff table

The transfer to a tariff increase is the interpretation of the levels of fares that should be charged in relation to the cost of production; more bluntly, whether a tariff increase is appropriate or not; the second element, application to tariff table, is the method by which any increase is realized.

Many UK authorities treat tariff increases as relative, that being the relative increase in operating cost applied to previous tariffs, rather than absolute costs being directly applied. The approach has merit given that some costs, such as fuel, fluctuate significantly. The relative method applyes an observed and modeled increase from one point in time, usually the last tariff review, to another – this tariff review. Resulting percentage changes in operating costs can be, and usually are, applied to the tariff table. Some instances exist where the tariff is not passed on in its entirety, often guided by the (perceived) impacts of tariff increases on the use of taxis.

The second element, application to tariff table, is more complex. Given that tariffs may comprise time, distance and engagement charges, the application of an increase can be based on an increase of each element by the same proportion (the percentage derived in the earlier steps), or a combination of varying increases resulting in an average increase at the level previously determined. The choice is more complex than it appears at first glance, not least in that the initial charge element impacts more greatly on shorter journeys, where an even increase across all elements may in fact result in a higher level of increase for shorter journeys.

3.7 Accessible Vehicle Models

An additional modeling element, the final element discussed here, relates to the use of accessible vehicles. Debate continues in the UK, and in most other

locations, about the best methods of providing accessible vehicles. Two possible approaches exist, the adoption of accessible vehicles across an entire fleet, or identifying (and providing sufficient vehicles to meet) demand.

The need to define demand and appropriate supply of wheelchair accessible taxis is contained in the UK within the Disability Discrimination Act 1995 (DDA), although the Act does not specify exact design types nor exact measures to enforce supply within the taxi trade. A consultation being undertaken by the DfT at the time of writing (DfT, 2009) may impact on this, and seeks views on the definition of a single vehicle standard, but this has not, as at the time of writing, resulted in formal vehicle specifications.

Licensing authorities have, at the time of writing, discretion to require use of self defined, accessible vehicles and are able to avoid their use where its requirement would have detrimental impacts on the wider supply of taxis. Ther is an allowance within the DDA mainly based on the higher costs (and thus economic impact on the industry) of requiring widespread use of such vehicles.

The presence of a local impact "loophole" specific to DDA should not detract from the desire to provide accessible transport and does, in reality, leave a number of options open to licensing authorities wishing to include such vehicles in their fleet. The primary options are:

- A requirement for all vehicles to be accessible

- A requirement for all new vehicles to be accessible
- A requirement for a proportion of vehicles to be accessible

The simplest form of control is the blanket requirement for all vehicles to be or become accessible. This has the significant advantage of being applied in equal measure across an entire fleet without a need for further detailed analysis.

The second choice applies the same principles to new vehicles, in that all new vehicles are accessible, with many of the advantages of the blanket application suggested in the first choice. Its disadvantages relate to the extended time period over which a fleet is replaced as a part of its natural lifecycle, as opposed to the timetabled application applying to an entire fleet. A further disadvantage may arise in that the requirement for all new vehicles to be accessible may impact on the purchasing patterns within the fleet, extending the life of existing vehicles (as an alternative to the purchase of new, more expensive vehicles).

The third, proportionate approach in contrast, seeks to identify demand both patent (observed) and latent (hidden). The approach defines numbers of vehicles required as a proportion of the fleet to fully accommodate demand for such vehicles.

Similar issues are faced in other countries, and have resulted in a number of alternative approaches including, in the USA, the mandated requirement to

provide wheelchair accessible vehicles in parallel to main transit corridors (under the Americans with Disabilities Act – ADA). The Republic of Ireland operates many transport services in line with the Disability Discrimination Act 2005 (DDA(I)), but as in the UK has not applied vehicle definitions to Taxi services.

The absence in many locations of a blanket requirement that all vehicles be accessible increases the need to be aware of actual demand, the numbers of trips likely to be demanded in accessible vehicles, and from this the numbers of vehicles appropriate for application in a fleet. The next section details an analytical approach to determining proportional demand.

3.7.1 Model of Proportional Demand (MPD)

The model of proportional demand seeks to determine the numbers of accessible taxis appropriate to their demand at any particular point in time. The model is predictive in that future demand is determined to include hidden demand, those journeys that would be made from within the existing population were accessible taxis available; but does not seek to predict increases in the general population number that would impact on the global demand for taxis.

The proposed proportional demand model seeks therefore to identify a level of future demand – in instances where sufficient numbers of accessible vehicles

are present, and determine the potential increase in journeys resulting from an increased availability of accessible taxis. The initial calculation is based on the formula:

$$FQD = CQD + \%\Delta QD_{ij}$$

Where:

FQD = Future quantity demanded

CQD = Current quantity demanded

% ΔQD = % change in quantity demanded for user groups i to j.

Potential change in quantity demanded is specific to location, and relates in this instance to the potential for increased demand as a result of requiring the use of accessible vehicles. Increases in demand (% ΔQD) are most likely to occur where previous use has been prevented by inability to access existing vehicles – for example in the case of wheelchair users. Other increased use may also occur where parents with children in pushchairs are prevented, by previous vehicle designs, to gain easy access to vehicles.

The measurement of change in quantity demanded does, however, require further interpretation; given that not all journeys occur at the same time, or are made for the same purpose, the calculation is further developed to identify the effect of peaks in demand. Responses in the access survey also allow for identification of points of peak demand, by journey purpose and by time of

day. As with the more general use of taxis, the most concentrated peak occurs in travelling home from entertainment, peaking at weekend nighttimes, and is concentrated on a peak hour. Other peaks include shopping and attending doctor or hospital appointments, although these were more spread through the day.

A Journey Purpose factor is applied to determine the number of journeys requiring accessible transport likely to occur – for example demand occurring at a point of higher demand. Variations in supply may also affect availability of accessible vehicles in a mixed fleet. The extent of supply available at any one time will vary by time of day, and by day of the week. There is no compulsion on a taxi driver to drive their vehicle at any particular stage of the day, and many will choose to operate at times felt convenient or attractive. Data from a Taxi Drivers Survey has been used to establish typical working patterns and to determine which hours are driven regularly by taxi drivers. A supply factor is included to identify, in the instance of accessible taxis being distributed uniformly across all taxi drivers, the actual number of accessible vehicles required to ensure sufficient supply at the point of peak demand. Given that the extent of a fleet available at any one point of time varies and is likely to be less than the total number of vehicles licensed with that fleet, the supply factor identifies in a given time period the proportion of the taxi parc available for engagement (See Cooper, 2009).

Further elements include a measure of vehicle utilization, used to determine the extent to which a single vehicle is able to complete more than one journey

in a given time period[13]. The combination of these factors provides an estimation of the numbers of vehicles required to supply accessible taxi services to demand identified. This is summarized below and defines the numbers of vehicles (VN) required to supply sufficient vehicles to meet demand. This number can provide a direct indicator of the total number of such vehicles required within the fleet.

VN = FQD x JP x SF x VU

Where:

FQD = Future Quantity Demanded

JP = Journey Purpose

SF = Supply Factor

VU = Vehicle Utilisation

3.8 Taxi Models, Links and enhancements

Existing taxi analysis, both as applied to quantity regulation and cost modeling approaches, have provided an effective method of determining supply and tariff in isolation. This does not however account for the presence of links between the individual modeling elements. Links exist and include links to the cost model (Table 3.5), and separately to the SUD model (Table 3.6).

[13] A taxi is able to complete a number of journeys in any one time period, depending on the length of journey, point returned to and frequency of engagement.

Table 3.5 Summary of linkages to cost model

Link between	Description
Authority requirements for disabled vehicles and vehicle purchase price	Impact of a change in minimum standards of vehicles on the market price of vehicles
Enforcement of MCF and disabled accessibility	Impact of enforcing MCF standard on the accessibility of vehicles to encourage use (demand) by potential travellers
Enforcement of MCF and vehicle purchase price	Impact of enforcing MCF standard on the purchase and resale values of a vehicle
Determination of maximum vehicle age and vehicle purchase price	Impact of enforcing a maximum vehicle age on the resale value of a vehicle
Standards set for roadworthiness and maintenance costs	Impact of changes in vehicle fitness standards and the costs of maintenance
Numbers of vehicles in operation and driver income	Impact of changes in the fleet size and ability of drivers to earn; and (where applied) on the income element of a cost model.

The identification and consideration of impacts in other regulatory domains on the operation of the cost model is significant as it permits calculation of effects of external impacts with a direct impact on operational cost. Thus imposition of a minimum vehicle standard requiring additional investment can be properly accounted for in prices charged to taxi users.

Table 3.6 Summary of linkages to SUD model

Link between	Description
Enforcement of MCF and vehicle purchase price	Impact of a change in minimum standards and operational cost on numbers of operators in market
Determination of maximum vehicle age and vehicle price	Impact of a change in maximum age and operational cost on numbers of operators entering market
Determination of tariffs and driver income	Impact of change in income on numbers of operators entering market, remaining in market, and operating at specific times of

	day
Standards set for vehicle roadworthiness and maintenance costs	Impact of changes in fitness requirements and costs of operation on the numbers of operators entering and remaining in market
Determination of waiting times and numbers of vehicles required in fleet	Impacts of change in acceptable waiting time on the nature of supply and numbers of vehicles within the fleet required to meet minimum service levels

The development of taxi models, as with the wider use of models in transportation, can be significant in determining the most appropriate forms of supply and in informing policies applied to the mode. Chapter four considers how the various models can be applied.

Chapter 4: Taxi Analysis - Application and Interpretation

Introduction

In Chapter Three we presented the main areas of analysis applied in the UK. We have addressed the methods by which both quantity and economic regulations are considered and applied to the Licensing Authority areas of Great Britain. In this chapter we expand this review by considering the core areas of common assessment and the application of taxi analysis in other locations. This chapter considers the common areas of analysis on the basis of purpose, and continues to consider the approaches seen in the USA and elsewhere.

4.1 Common Approaches

The basic need to analyze a taxi market arises from the desire, and in some instances legislated requirement, to ensure the market operates in the best interest of the traveling public. It is noted that the needs of the public may differ across time periods, and may also differ between short-term benefits, medium and longterm industry structural stability. The moves across many countries to introduce regulatory reforms have been based on the desire to ensure properly operating market benefits to the consumer. Additional moves were to deregulate a previously highly controlled industry resulting in a range of impacts from short-term gains in taxi numbers, to the more questionable benefits of industry stability over a longer period of time. The reforms applied in the Republic of Ireland, the removal of quantity restrictions in

2000, have taken just short of a decade to result in industry decline, and a loss of income to individual taxi drivers resulting in increasing protests and demonstrations in 2009. The market argument that any such fluctuation will be balanced by a new equilibrium of supply to demand has been taken thus far to high levels of over-supply, impacting on income, and may well take a similarly protracted period to respond in order to achieve a further equilibrium.

Deregulation in the US, in the period to 1984, has had a similarly protracted impact. In both instances the nature of the taxi market altered, reducing the certainties of the previous systems, and changing the needs for and necessary approaches to taxi assessment.

To define this further and to apply the concepts of an analytical approach to a changing regulatory structure we will now look at the common approaches to taxi models.

4.1.1 Taxi Markets (Supply and Demand)

The analysis of a taxi market, both in terms of the supply of taxis and in the determination of demand relates to the regulation or observation of quantity. The UK SUD model, described in detail in Chapter Three, seeks to define a measurement of unmet demand, which is further applied to inform the supply of taxis in any location. A demand model is similarly applied in a number of studies the US, identifying areas of waiting time, as detailed in Section 4.2, but differing from the approach in the UK,

by providing correlations to the structure of the (more diverse) US taxicab industry against a continuum of taxicab firm types.

Both US and UK models adopt an approach based on a shortfall in the level of supply in specified areas of a city, but differ in the methods by which such may be addressed. It should also be noted that the actual structure of the market differs between the countries, with the US having a greater dependence on the dispatch market for taxis, compared to a greater use of hailed and cabstand markets in the UK. This difference will impact on the feasibility and practicality of one form of assessment over another, and has a particular influence on the methods by which data may be collected.

A further approach, adopted in a number of US cities relates to the use of multiple regression analysis (Schaller, 2005) using three primary demand factors (in New York), commuting by subway, numbers of no car available households, and airport taxi trips (see Section 4.2.3, below).

4.1.2 Taxi Costs (Tariff / Cost Models)

A further distinct area of analysis in the supply of taxis relates to the determination of tariffs. Taxi tariffs, initially defined in Section 3.6, are the basis upon which fares payable are defined. Consistent approaches to the assessment of costs do exist and have been applied as a matter of course in most UK locations, with a similar, but less structured approach adopted elsewhere, illustrated in Table 4.3, below. A number of structures may be applied in the determination of the tariff, the most common of

which, in the UK, relate to the updating of a cost model used to inform a taxi tariff table by authority, and from this, the amounts be applied to taxi fares.

Taxi fares, being the total amount payable for any one journey, differ from the taxi tariff, being the structure by which the fare is calculated. Most, but not all, fares are comprised by a combination of time and/or distance traveled, with many including an initial charge for taxi engagement commonly called a "flag drop" or "flag fall", referring to the initial mechanical taximeter requiring the physical movement of a for hire "flag" to start measurement.

The flag fall charge is included by many authorities to accommodate the increased costs of accepting short distance journeys, being the opportunity costs of leaving a position at the head of a queue of taxis at a cabstand, and may either be applied as a charge including a prepaid distance, up to which point no further charges are applied, or stated as a higher cost to mile one, an approach common in the US.

UK authorities require, under the meanings of the local and civic government acts, the taxi tariff to be published and available to the passenger in vehicle. A similar approach exists in the US with a number of authorities requiring the display of mile-based charges on the external door panels of a taxi.

The need for a formalized approach to determining operating costs arises from the UK legislated requirement to undertake tariff reviews on a regular basis, although no similar requirement exists in the US. The method by which cost models are applied can differ significantly both within the UK and US, and in comparison to methods

applied elsewhere. An implicit assumption of the operating costs of a taxi is common in the UK, with many authorities choosing to adopt costs provided, and sometimes without verification, by the industry. Cost models have also moved from absolute measurement of costs to a comparative update, ranging from a calculated update from a typical cross section of verified costs to the far less sustainable comparison of one authorities fares to another. The latter is based, in some instances, on the assumption that another operator has taken the time to measure costs, and it is then applied, again in a limited number of instances, without verification.

Differences can also exist in the methods by which measured increases in tariff are applied to the tariff table. This is best exampled in the instance of a measured 5% increase in costs being applied differently to flag drop, time and distance elements. A common discussion in the UK relates to the desire to maintain silver coin denominations (typically 10 or 20 pence steps) in the fare charged. This does not sit well with increases in tariffs that result in an increased cost of odd numbers of pennies. Solutions popular with the trade include a reduction in the amount of distance purchased within a single unit of cost, rather than an alteration made to the cost of a unit of distance. It is also difficult for flag drop charges to be altered precisely by a specified increase, as the flag drop includes both engagement and included distance elements and may, in reality, relate to trips below the included distance. Any change to a flag drop charge will have a disproportionately high impact on shorter journeys, and has been demonstrated to result in increases in actual costs to passengers significantly above the stated increase in tariff.

Common approaches to costs models relate to the desire to ensure appropriate fares charged for taxi use. The existence of a review procedure, and the instance of setting or enforcing maximum fares indicates the need to limit charges and may, in reality, be an indicator of market failure, the inability of an uncontrolled market to operate competitively. While the presence of taxi cost models is not, in itself, an indicator of widespread market exploitation, it is indicative of a need for clarity in charges and their determination.

4.1.3 Quality Models

The controls applied to taxi quality vary significantly between locations, with a range of legislated and agreed standards being applied in many. The concept of controlling vehicle standards tends to be addressed in isolation, away from the discussions of quantity or economic controls, and are mainly allied to the determination of vehicle standards, and occasionally vehicle type. This said, the majority of locations worldwide, and all UK and US authorities require a minimum level of vehicle safety (roadworthiness) to be applied, and most determine testing regimes specific to taxis.

The impact of quality controls on the market for taxis is less clear than that arising from policies limiting numbers of licenses, or those impacting on tariffs. This does not mean that the application of quality controls will have no impact but rather, that this impact is derived, and hidden. Furthermore the consideration of quality control in isolation has the effect of reducing the extent of analysis between regulatory forms or of the impacts of such controls in the other domains.

Analytical models of quality control relate, in the UK, to the vehicle standards test, sometimes called an MOT or PSV test; and in the US to similar controls. The impacts of quality controls on other regulatory domains include an increased cost in operating in markets that limit vehicle ages and/or vehicle type. Some North American locations have sought to reduce fleet size by applying a maximum vehicle age, but only limited evidence exists to comment on the success such an approach may have.

In Section 4.2 we continue to look at the application of the varying approaches to analysis in the US, and in subsequent sections to other countries. We will address, in each, the experiences of regulatory reform in each location, and comment on the impacts that prevailing structure and political viewpoint may have on the application of taxi analyses.

4.2 Taxi Analysis in the USA

Experiences of regulation can differ significantly between locations, with such regulations as exist being reported on a widely differing basis, often allied to a particular viewpoint for or against regulation. Given that taxi regulation forms the basis of much of the subsequent analysis and modeling, the nature of the underlying regulatory structure will have a significant impact on the forms of analysis being undertaken.

Much of the reported regulatory experience in the US arises from a series of high-profile cities choosing to deregulate in the period between 1979-1984. An account of

the deregulation, and its subsequent re-regulation is set out in Chapter Two, and most commonly exampled by the removal of quantity, and in some instances price, controls. Several rationales for the US regulatory reform are given (Teal and Berglund, 1987) which include the belief, at the time, that entry restriction, and the resulting lack of competition, had enabled incumbents to maintain high prices. A further belief was forwarded that deregulation would raise the levels of service offered by taxi suppliers - as levels of competition increase, quality benefits would result. Thirdly, that deregulation would provide an incentive for a greater variety of price/service options, including the concept of shared ride taxis.

Deregulation remains an issue of much controversy, with the experience of US deregulation being felt to be mixed. The results of US deregulation appear, in many commentaries, to have failed to deliver the extent of benefits initially anticipated. Experiences of market expansion vary widely with many cities reporting limited growth, see Table 4.1.

(Insert Image: Table 4.1)

Table 4.1 Change in Size of Taxi Industry Following Deregulation

Source: Gelb, 1983a, 1983b; Teal et al, 1984

While the majority of cities did experience an increase in the numbers of vehicles, Table 4.1, only a few, such as San Diego and Pheonix, experienced a significant change. The same cities, particular in San Diego, also reported an increase in service refusals. Taxi fares increased following deregulation sometimes resulting in significant increases in fares being charged.

It is against the background of a significant, but not always positive, experience of deregulation, that current American taxi analytical models are based. These vary significantly, in both historical experience and ultimate aim from those applied in the UK. US locations addressed issues of significant price rises and identified falls in supply compared to the UK approach to satisfy demand.

4.2.1 US Frameworks for comparison

A major element in much US analysis is the consideration of the suitability of a particular market type to meet the needs of a specified location. There is (Mundy, 2009) "considerable confusion" as to an accurate definition of a taxi company. Taxi companies can be, and often are, very different – even within the same community, and this variation impacts on the levels of service being offered, and can impact on the levels of fares being charged.

Figure 4.1 sets out a continuum of taxicab firms by type, comparing company orientation to driver orientation. The various categories of company are identified according to the extent of corporate as against individual responsibility, with subsequent analysis, in part, allied to the appropriateness of the predominant operation type.

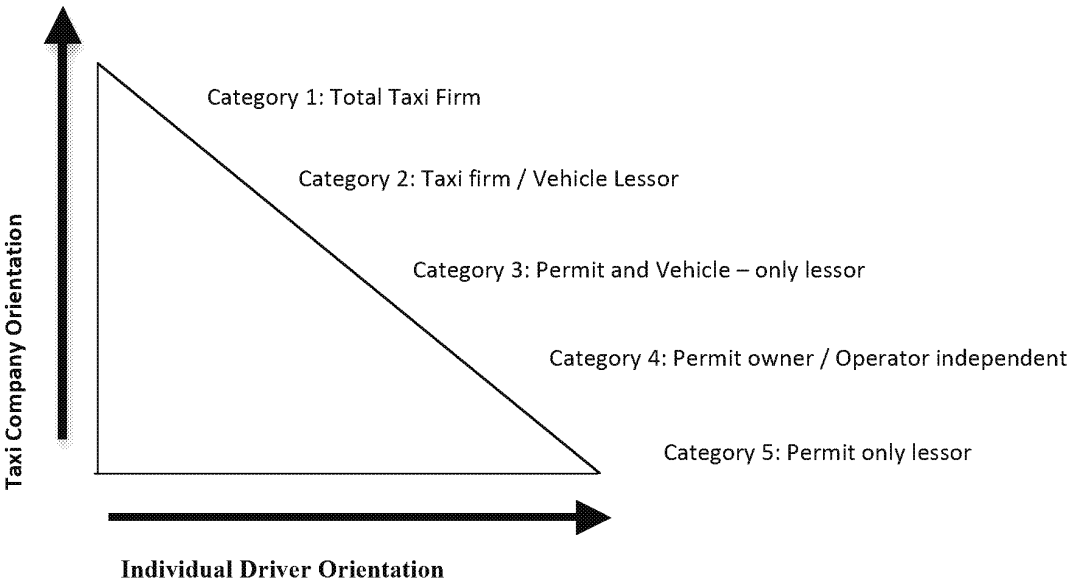


Figure 4.1 Continuum of taxi firms in US supply

Source: Authors

The continuum ranges from the total taxi firm, one that adds significant economic value to the city's taxicab permit, down to a simple permit holder who leases the taxi permit. At the upper end the total taxi firm uses their own employees, adding value through centralized dispatch and employee benefits; at the lower end the community inherits many of the responsibilities of centralized facilities. The structure differs from that in place in the UK, where total taxi companies are rare, with the closest correlation in city operations being between categories two and three, the UK taxi driver tending to lease vehicles while subscribing to a larger radio circuit.

It is noted that exact comparisons are not possible. However, the presence of regulation, particularly on the numbers of licenses does impact on the structure of the market in both the US and the UK. Company structures also impact on the provision of centralized services, whether through a total taxi firm or a subscription service,

more typical in the UK, and specific to dispatched taxis. Higher-level companies might also, it is suggested, maintain a more extensive record as to vehicle movements and passenger fare box revenue.

Mundy (ibid) reports an issue arising in some US cities in that regulation has been determined specific to higher level company operation, a more centralized level of control, while the reality of supply is seen at a lower end, where control is passed to individuals and small groups of sole traders, with the effect of reducing the availability of services to the individual, although this is, to some extent, being addressed with the emergence of new technologies, including Google Ride Finder. A review of the impacts of new technologies within this group is set out in Chapter Six.

Other North American operations fall within this approach, with a comparable service in Calgary, Canada, being identified as similar to a Category Three operation, but delivering Category One benefits. It is likely that a similar comparison would be applicable in major UK cities.

An added issue noted and specific to lower level companies is that many of the central functions undertaken in the higher level companies, and in the UK by Taxi Operators Associations, are assumed by cities and airports. Community Regulatory Agencies adopt many of the functions that the fully operating company would negate, including ensuring quality standards are upheld; in the UK this would be reflected by the voluntary codes adopted and in some cases operating standards imposed, by the taxi company or TOA.

4.2.2 Demand Analysis

In common with the SUD use of waiting time, many US studies adopt a service level based on the delay in engaging a taxi. The UK SUD model has tended to use observed delay at stance as a standard indicator of service levels, and this forms the basis of conclusions specific to the numbers of vehicles appropriate. The lower the extent of waiting times, the less pressure exists on increasing taxicab licenses. The SUD model goes one step further by setting thresholds for delay and measurement based on the reduction of that delay, though some criticism exists of the exact definitions of these thresholds, including observed differences between their definitions in current SUD studies (see: Halcrow, 2002), and commentary within the OFT report (OFT, 2003).

The concept of a threshold for delay relates to the definition as to what can be considered a reasonable waiting time for a taxi. Delays occur naturally at a stance from the time taken for a vehicle to draw up, load and depart with many of the standard approaches in the UK discounting maneuvering time. In this way, the measurement of delay at stance commences only beyond a threshold delay, typically of one minute. This does not accommodate differences in the expectations of delay specific to the performance of a taxi stance, with a number of more recent studies (see: Cooper, 2003) aligning thresholds to minimum stated service levels, which vary significantly by time of day. A minimum service level accommodates the differing conditions of supply across time periods by defining the thresholds for acceptable and excessive delay from public survey. A similar approach is observed in a number of

US studies (see: Mundy, 2006, 2007, 2008), and includes an analysis of taxi supply in Miami-Dade County defining average and reasonable delay.

4.2.3 Regression Analysis

US studies tend to address taxi demand analysis for the purposes of determining the total number of taxis that should be in their community. This has been done in a variety of ways. Historically, population levels were utilized to cap the number of taxi permits at the present level to settle disputes by taxi company owners and additional service applicants. This number of taxi permits was then expressed as "X" number of taxis per 1,000 population.

For obvious reasons, this methodology, for determining taxi demand and translation into the appropriate number of taxi permits was seriously flawed, other than as a popular convenience. It often fixed the number of taxi permits per company without respect to actual service levels the taxi company may have been offering, their quality of vehicles, and the returns to driver or company for providing these services. In addition, no two population centers are alike with respect to tourists, income levels, automobile ownership, amount of public transit and other competitive forces, walking distances, taxi fares, etc. Furthermore, some population centers have very wide city boundaries demarking the population under consideration, including very low density areas, while others may restrict the city population definition to a significantly smaller, denser area. Population is definitely not a reliable or even a good starting point for determining taxi demand and establishing an appropriate number of taxi permits for a community.

Unfortunately, even today, newspaper editors, and even some researchers still produce impressive looking tables comparing the number of taxi permits with population levels and calculating the ratio of taxis per 1000 population. A better and much more accurate, approach when actual taxi demand data is not available, if one is going to employ surrogate numbers for estimating taxi demand, is to utilize multiple indicators or drivers of taxi demand such as income levels, automobile ownership, airport de-planements, transit ridership, taxi fares, etc. collectively in a linear regression analysis to estimate taxi demand and the appropriate number of taxi permits. One of the best works on this process for determining the number of taxicabs in US cities was authored by Bruce Schaller of Schaller Consulting (Journal of Public Transportation, Volume 8, No. 5, 2005.)

Regression vs. Actual Data Analysis

As further evidence of the fallacy of utilizing population as a single variable for determining taxi demand in a city, Schaller presented a plot diagram of the existing (2004) ratios of population to taxis per 1,000 population pictured below:

(Insert Image: Figure 4.2)

Figure 4.2 Ratio of Taxis per 1,000 Population

Schaller, Op cite, p. 4

As shown, there exists significant variation in population to the number of taxis per 1,000 population. Having observed this, Schaller presents a more comprehensive

conceptual model composed of seven independent variables for determining the number of taxicabs for a city, composed of seven independent variables depicted below. As shown, the dependent variable in the conceptual model is taxi demand.

(Insert Image: Figure 4.3)

Figure 4.3: Schaller Taxi Demand Model – Schaller, Op city, P. 5

Using data from the Taxicab, Limousine and Paratransit Association (TLPA) 2002 Fact Book (Taxicab, Limousine and Paratransit Association 2002 Taxicab Fact Book, 2002), and local newspaper accounts, Schaller populated this conceptual model and regressed each of his independent variables against the single dependent variable as the number of taxicabs. Through this work Schaller presents further empirical evidence that population alone is not a reliable indicator of taxi demand.

"This study identifies primary factors related to demand for taxicab service in the US Regression modeling of the number of cabs in 118 U.S. cities finds that most of the variation in the number of taxis can be explained by (1) the number of workers commuting by subway; (2) the number of households with no vehicles available; and (3) the number of airport taxi trips." (ibid, p. 1)

As noted however, this regression analysis only reported on the relationship of these variables to the current number of taxicabs within each city – not the actual demand for taxicab service. Thus, one is left with the conclusion that while any model of taxi demand should surely incorporate the variables of subway workers, households with no vehicles available, and airport taxi trips, this is no guarantee that the objective of

determining the appropriate number of taxicab permits to issue will be met. It could be argued that many of these 118 cities actually have too many or too few taxis.

A far better approach would be to use actual taxi demand data to determine the appropriate number of taxicab permits for a city to issue. Actual taxi demand data historically could be found from taxicab log books where employee drivers were required to write down the time of each pickup, fare, origin, and destination. Substantial fines and loss of job could be levied against the driver if these logbooks were not kept current and matched revenues from the taximeter.

Today, however, with the almost universal use of independent contractor taxi drivers in the US and lack of enforcement with regard to taxi driver log books, this data is just not available through individual drivers. However, with the use of newer taxi technologies (see Chapter 5 – The Role of Technology in Taxi Operations) actual demand data is captured electronically and is available for detailed analysis of taxi demand.

4.2.4 Analysis by Actual Data

Analysis of taxi customer pickup data can provide insight into several areas such as the total demand for taxicab service, demand concentration, wait times, trip durations, and the impact of geography and demographics on the service levels. An understanding of these factors helps to determine whether a city or taxi company needs more or fewer vehicles on the road.

Depending on the level and type of data available, one can aggregate the data yearly, seasonally, monthly, daily, and even hourly for each zipcode within a service area. The service levels can then be displayed on a map to show the contrast between zipcodes. In addition, this data can be displayed on a map as a function of average income, population, education level, and other desired demographics.

While many taxi companies use zones in place of zipcodes, using customized geocoding software allows the analyst to use either a street address with city/state or latitude/longitude data to find the zipcode for each trip at approximately 90% accuracy. One can then aggregate data by zipcode and then visually represent the data on maps.

As taxi companies continue to adopt new technologies, opportunities exist to better understand the consumer demand and service levels for both individual companies and regulatory agencies. The following examples show the benefits of using taxi data to understand the performance of a single taxi company or even the entire industry within a city.

While most large taxi companies utilize computerized dispatch software, many smaller taxi companies only have driver log trips on paper. Analysis can be conducted using data from either method. The electronic data saves significant time and allows analysis to include a larger data set. However, data can be input into a computer from manual records as well. Figure 3 shows one example of a manual paper record of all

trips undertaken. (The individual pickup records have been blanked out for privacy reasons.)

(Insert Image: Figure 4.4)

Figure 4.4 Example of a Manual Trip Record of all Trips

4.2.5 Data Presentation

Whether data is generated manually or electronically, valuable insights to taxi operation are possible. Figures 4.5 and 4.6 show distributions of the average number of dispatched trips completed by drivers and the taxi is driven only one shift, vehicles respectively in a single day or shift. Often taxi companies will provide data on dispatched trips but are hesitant to let drivers and others know that their newer taxi technologies also retain all trips undertaken whether dispatched, picked up at a stand or even a flat fare trip when the taxi meter is utilized to provide a receipt as in the case of most U.S. cities. The first chart clearly demonstrates that, in this company, the mean number of dispatched trips in a shift is eight to ten trips. As the second chart illustrates, the mean dispatched trips per vehicle matches that of the drivers. For companies where drivers do not own their vehicle, this would not be an efficient use of the asset.

(Insert Image: Figure 4.5)

Figure 4.5 Distribution of the Average Number of Daily Dispatched Trips Completed per Driver

(Insert Image: Figure 4.6)

Figure 4.6 Distribution of the average number of daily dispatched trips completed per vehicle

4.2.6 Call Completion Analysis

Another important measure available from actual data is the call completion rates. The following table shows an important component of a successful taxicab company. Trip completion is the percentage of all calls that actually resulted in a paid passenger. This can show if a company has an unusually large number of calls being lost possible due to long wait times or taxi drivers not responding to the offer of a fare. This could indicate unmet demand or the unwillingness of some drivers to accept a fare to areas they do not with to go.

4.2.7 Trip and Wait Durations

Figures 4.7, and 4.8 are good examples of how data can determine whether the taxi company is adequately meeting the needs of passengers and whether more taxi permits may be needed. Figure 4.7 shows a company where approximately 90% of customers experience a wait time of 15 minutes or less. Figure 4.8 shows another company where only 60% of customers wait 15 minutes or less. In addition, some passengers waited more than an hour.

(Insert Image: Figure 4.7)

Figure 4.7 Distribution of the wait times

(Insert Image: Figure 4.8)

Figure 4.8 Shows a Distribution of Wait times with a Larger Range of Wait Times and More Permits may be Required

Understanding the nature of taxi trips is also important to determining the appropriate number of permits to authorize. Figure 4.9 illustrates zipcodes that have higher average wait times. In this map, clearly there is an apparent correlation between higher wait times and geographic location.

(Insert Image: Figure 4.9)

Figure 4.9 Average Wait Times per Zip Code

4.2.8 Concentration of Pickups

The maps shown as Figures 4.10, and 4.11 show the concentration of trips by zipcode for two different companies. Each zipcode is assigned a percentage based on the percent of the total trips that originated from that zipcode. As can be seen, these two companies have significantly different primary service areas.

(Insert Image: Figure 4.10)

Figure 4.10 – Company A Trips

(Insert Image: Figure 4.11)

Figure 4.11 – Company B Trips

Demographic Effect

Finally, once data is drawn into U.S. zip codes, additional data from the U.S. Census conducted every 10 years, can be overload to see taxi service levels by income level, race, and other demographic variations. The last three maps show how a high number of incomplete trips might or might not be related to demographics. The first map (Figure 4.12) shows three groups of rejections. The second map (Figure 4.13) displays the 2000 average household income by zipcode. The last map (Figure 4.14) presents the population as projected for 2005. A comparison shows there is a potential relationship between the high rejections and lower income areas. It also shows that there is not necessarily direct relationship between high rejections and population concentration.

(Insert Image: Figure 4.12)

Figure 4.12 – Number of Rejections per Zip Code

(Insert Image: Figure 4.13)

Figure 4.13 – Average Household Income in 2000

(Insert Image: Figure 4.14)

Figure 4.14 – Projected 2005 Population

4.2.4 Cost Analysis

As in the UK, the use of a standard approach to taxi analysis is less well developed specific to taxi fares in comparison to demand. This said, a number of reviews are available and tend to be completed specific to a single location rather than in relation to a wider and more systematic approach.

As in the UK, a maximum tariff can be applied to the charges levied for using a taxi. As the general costs of living, and those of operating a taxi increase, it is logical and desirable to allow for increases in tariff. Increases in the costs of living may be generally measured against consumer price indices, or other measures of inflation, among them retail prices, costs of living, housing etc. Consumer prices provide a good indication of the general increases in costs of living and these may provide a backdrop against which increases in fares may be seen as justifiable, but do not, in themselves, provide a full or detailed review of the actual changes in costs of operation. The general increases in cost of living also do not show the level of efficiencies attained by the participating taxi companies. Only through analyses of detailed ridership per vehicle, as depicted in Section 4.2.3, can one know how efficient their regulated taxi firms are.

The US consulting company, Ryan Snyder Associates, reports on the use of a "transportation price index" in Los Angeles against which levels of fare increases can be monitored, but this appears more as a reactive validation of taxi fares than a proactive measurement of the changes in costs applied to a basic cost of operation, being the approach more common in the UK. A detailed commentary in the Gotham Gazette by taxi consultant, Bruce Schaller (Schaller, 2003), similarly questions the methods applied to taxi fare analysis, stating that the New York Taxicab and Limousine Commission, the licensing authority for New York, had "not conducted it own analysis of taxi expenses or the need for a fare increase in nearly a decade…". The article continues to detail that the commission is required, under City charter, to consider "all facts which in its judgment have a bearing on a proper determination " of whether to grant a fare increase. The lack of a detailed analysis of taxi costs (as opposed to taxi fares) reinforcing the possibility that taxi fare increases in some US locations are determined without formal knowledge of or reference to actual costs. Table 4.3, below, sets out the main processes by which meter rates are set in differing authority areas. It can be noted from the table that a significant number of authorities adopt comparative rather than actual fare increases.

The main approaches differ, by jurisdiction, and can include consumer price index and cost measurement approaches. It is worth noting that the use of price indices varies between locations with a Consumer Price Index (CPI) relating to a general increase in prices, sometimes referred to as inflation, with some use of an Industrial Price Index (IPI), more common in the UK, or a Taxi Cost Index (TCI) included in the Los Angeles review of taxi tariffs (City of Los Angeles, 2007).

The San Francisco Taxicab Industry Report (CCSF, 2006) provides an update on rates and fares within the San Francisco taxicab industry. The report tends to support the view of a comparative approach to fare determination, positioning San Francisco fares comparatively against other US cities as a major factor in the determination of fares. The same report details a logical position in terms of increases arising from sharply increased fuel price,s using a cost price index based on the wider costs of private transportation. In the instance of taxi fares in 2006, they resulted in an increase, applied as a fuel surcharge. A similar approach, adopted in Los Angeles (ibid) adds a fuel price increase element to TCI calculations, otherwise drawn from CPI according to specified weightings.

CPI approaches benefit from their simplicity, effectively taking the measurement of consumer prices, as measured by an official statistical organization, and applying them selectively to the operating costs of a taxi. Shortfalls exist where the costs of various constituent parts, such as the costs of insurance, repairs etc., differ between standard consumer costs, and those experienced by taxi drivers.

4.3 Worldwide Experiences

Similar analysis is observed in other locations, and this is often highlighted as countries discuss merits of regulation or deregulation. Recent analysis includes discussions of regulatory reform in Sweden (Marell and Weston, 2001), and in Ireland (Barrett, 2003); with similar reviews in New Zealand (Gaunt, 2006), and Australia (Industry Commission, 1994).

The following sections provide an overview of the use of analysis in other locations, and detail the discussions specific to each.

4.3.1 Republic of Ireland

The experience of deregulation in Ireland, which occurred following judicial review in 2000, addressed the need, at the time, to reduce delays in accessing taxis, particularly in Dublin late at night. The reform owed some of its justification to an analytical review undertaken by Fingleton (1997), correlating an increase in license numbers under regulation, to that that may have been expected in line with growth in GDP. The Fingleton report stated that the increase from 1,974 licenses in 1997 to 2,724 in 2000 under regulation should have equated 4,200 licenses in 2000 had the increase been parallel and linear to increases in real GDP. Similar reviews of the time (Oscar Faber, 1998) undertaken prior to deregulation suggested that public opinion, based on interviews, would be in favor of deregulation; with those undertaken immediately following deregulation (Goodbody, 2002) suggesting a majority of the public feeling the move had been successful.

While the deregulation of taxicabs in Ireland has undoubtedly had an impact on the numbers of vehicles licensed and in circulation, with a significant increase in the issuance of licenses under deregulation, it is highly questionable whether the modeled benefits have been fully realized.

In their initial submission, Fingleton, 1998 suggested that increases in the numbers of taxis had not been maintained at a level sufficient to match the economic growth in Ireland (see: Moore and Balaker, 2006). It is noted, however, that in his ruling, of the 13th October 2000, Mr. Justice Murphy did not seek to establish a "correct" number of taxis, but rather that the presence of restriction was unlawful.

A number of studies since have reported on the development of the industry since deregulation, including those generally favorable to deregulation (Daly, 2004), a number identifying the more negative impacts of excessive levels of supply on the driver and taxi trade. While these issues have followed slowly, by 2008 a genuine issue was being identified as income levels dropped, that a current equilibrium exists with low levels of income and genuine hardship leading to significant protests on the street.

4.3.2 Sweden

Deregulation occurred in Sweden in 1990 with the removal of both quantity (de-restiction) and economic (tariff) controls. Arguments made at the time of deregulation concentrated on the feeling that the industry, under regulation, was inefficient as entry controls caused a mismatch of supply and demand (Marell and Westin). The move removed a requirement, of county administrative boards, to estimate the demand for taxi services in each area.

As with deregulation in the Republic of Ireland, the moves in Sweden did not seek to revise limitation, but rather to remove its requirement, and thus the need to undertake

specific analysis of the demand for taxis, these being appropriate only where some quantity controls are maintained. Similar parallels exist with the experiences of the Republic of Ireland in respect of a sudden uptake in the numbers of licenses being issued but, unlike the Irish experience, a significant drop in registrations followed, see Figure 4.1, above.

Furthermore Marell and Westin suggest that despite increased numbers of licenses, "more taxicabs do not necessarily mean that the total supply time increases", an observed impact relating to the available taxi shift time (cab shift availability) and specifically that increases in total numbers of vehicles does not result in a linear increase in their availability. "Log data shows that in the first years after deregulation (1990–1994) the average traffic time per taxicab decreased in most municipalities and thus, despite more taxicabs, the estimated total supply time decreased."

While a number of other locations having deregulated also suggest a mismatch between license numbers and cab shift availability, only limited evidence exists beyond that demonstrated in Sweden.

4.3.3 Other countries

Japan and the Netherlands have similarly derestricted their taxi markets. In Japan issues have arisen in relation to over-supply (Iwaki and Kamata, 2008) highlighting a

conflict between driver propensity to supply and relative patterns of supply, including issues of driver and vehicle availability, and drivers' perceptions of key markets.

4.4 Potential development of new modelling

While it is understandable that the main areas of taxi modeling relate specifically to the determination of regulatory form, this may, in fact, represent something of a barrier to their continued use. The majority of models in the UK have tended to consider the numbers of licenses appropriate within a restricted system, these determining the levels of change in license issuance appropriate if that system is to be maintained. As, and when, decisions are made to deregulate, the original purpose of the model is lost – there being no purpose in justifying restricted license numbers in a system with no limitations imposed. This, however, does not fully justify the wholesale loss of demand models. It is specifically noted that the authorities that have chosen to deregulate have not necessarily achieved the levels of equilibrium between supply and demand desired, or even predicted, in the lead up to deregulation.

The emergence of a disconnect between taxi license numbers and actual cab shift availability has not been fully explored, and this has the potential for detailed analysis to the benefit of the travelling public and the taxi trade alike.

Such controls as remain within the remit of licensing authorities, indeed of wider road authorities, continue to benefit from the application of effective analysis tools,

examples of which include the potential development of stance location and facility development tools.

Moreover, the actual links between regulated and deregulated markets do not reflect an absolute position between detailed analysis and no analysis. Indeed, the absence of regulation in one domain may actually predicate more accurate analysis across others or all regulatory and potentially controlled areas. Technologies also impact on the particular market forms, as for example where mobile phones have increased access to the private hire market, oar where radio dispatch allows for a better response rate to dispatched journeys, considered in more detail in chapter five, below.

Chapter 5: The Role of Technology in Taxi Operations

Introduction

Information technology and software evolution has played a role in most transport modes, and taxis are no exception. Information is often referred to in business as a substitute for actual inventory and hence the overall cost of goods. The more complete and faster information is, the better it is and the more valuable it is in reducing costs. Information plays the same role for taxicabs. The greater the amount of information and the faster one can obtain, process, and make decisions with the information, the better off the taxi system will be. This chapter details the development and current use of technologies specific to current taxi services. The chapter identifies differences between technologies commonly in use in dispatch, including digital dispatch systems, and those in common use in other areas of taxi provision.

5.1 Development of technologies

Early on, in the original "hackney" days of taxi services, taxi drivers worked their stands, hotels, hails, and other public places where users could easily find and engage them. Taxis were one of the first industries in addition to police forces to use two-way radio operation,s thereby expanding and enlarging the market they were attempting to serve and the way they served them. With the advent of the telephone

and two-way radios, taxis could now take assignments from other than walk-up traffic as well as to "store" an inventory of business in the form of reservations for pickups.

Early taxi technology would be considered awkward and quite crude by today's standards. Taxi operators had to purchase a radio frequency just like any public broadcasting system and operate the license in much the same way over the airwaves. That is, each request for taxi service would be broadcast to every taxicab driver who had a radio with a chip in it that would receive that taxi company's signal. While a great enhancement to taxicab operations it did present one problem. It depended upon the drivers being honest as to where they were and their ability to make a pickup within a short while.

(Insert Image: Figure 5.1)

Figure 5.1 An Illustration of Early Taxi Radio Systems

Often drivers who were not busy would reply to a general radio call that they were within a few blocks of the hotel guest requesting a pickup while, in reality, they may be miles away but want the trip. Radio chatter may involve drivers bidding for fares by saying that they were even closer – just around the corner when they were much further away.

Dispatching during these early days was obviously a challenge and good dispatchers might require several years "on the job training" before they became especially efficient in mastering the skills required to know all locations and keep in mind where each of the company's taxis were as the day went along. In order to assist them,

dispatchers developed several clever devices. One was the map and peg or symbol system whereby the dispatcher would have a huge map of their service area and place little metal tags or pins with the car numbers on it. These map and pin systems could be made out of paper, or metal which was easier to use with magnetic car numbers and tended to last significantly longer than paper maps and pins.

Another common method was to have small boxes, Figure 5.2, representing zones of the city into which the dispatcher would place a slip of paper whenever he or she assigned a taxi delivery to that zone. Then, when he got an incoming call for service from that zone, he could look at the slips to see what cars he should have in that zone. This method was easy and effective, and a single dispatcher could keep track of infinitely more cars this way than memory alone would serve.

(Insert Image: Figure 5.2)

Figure 5.2 An Example of Taxi Zone Box Dispatching

The use of common radio waves however presented a unique problem that grew out of the US deregulation of taxi companies as discussed elsewhere in this text. With a larger number of competing taxi companies and drivers out on the streets, competition for every fare became quite keen. Individual taxi drivers would install radio chips containing the frequencies of not only their own dispatch (which might be quite limited or non existent), but also chips with the frequencies of other taxi companies who may have more business.

Thus, a driver could hear the public broadcast of several taxi companies and the location of the proposed passenger. Drivers were aware that if they were the first on the scene, irrespective of their identity as different than the taxi company called, they would get the fare. Later, the use of radio "scanners" also served this purpose quite well and was significantly less costly. Many local regulatory authorities banned the use of such radio devises and some fines were severe, but these punitive measure alone could hardly stop this lucrative practice by independent and even bandit (unregulated) taxicab drivers. The development of small portable detachable scanners only increased the problem.

Radio technology came to the rescue with the ability to send and receive a signal to only one vehicle at a time, thereby foiling others wishing to "scoop up" the passenger. (In Canada, for example, the practice of poaching another's dispatch or intercepting passengers illegally at the airport (solicitation) was and still is commonly referred to as "scooping".) However, this advance in taxi radio technology created another issue for drivers and company officials to deal with, that of claims (real or perceived) of dispatcher favoritism. Drivers would learn of other drivers who appeared to them as being the only ones receiving the really good runs, so there was often the accusation or at least suspicion of some drivers paying off the dispatchers for the better dispatches.

The advent of further improvements in taxi dispatch technology has helped to remove these suspicions to a large degree. Computerized dispatching systems that automatically route the request for cab service to the closest vehicle as identified by the vehicle's onboard GPS device (or to the taxicab that has been in that geographic

zone the longest, and by operational rule is to receive the next offer for service) are available from many of the current providers of modern taxi dispatch systems.

Management of the individual taxi operator has also been improved by these modern taxi dispatch systems. By continuous tracking of the routes selected by the driver, the computer can red flag any driver who takes a longer route. Some systems will automatically provide turn-by-turn directions for the driver and flag any trip, which is more than one percent (1%) out of specified route. Such electronic records are extremely invaluable in settling any claim by a taxicab user that the driver took the long way, thereby inflating the fare.

Without the connectivity of radio/electronic dispatch, a large percentage of taxi operations in North America take place without the benefit of these modern taxi dispatch technologies utilized in the taxi industry to improve efficiency and productivity. These are technologies that have helped other taxi operations to maintain and even regain passenger traffic market share once lost to other competitors.

Foregone is the ability to use GPS technology for closest cab dispatching, electronic processing of credit cards, shortest route directions, immediate dispatch of police to the exact location in the event of an incident, dispatching of accessible vehicles when required, electronic payment of corporate or voucher business, elimination of manual record keeping, and any hope of lowering costs and fares through more efficient operations. Without these new taxi technologies offered by full service taxi operators, in selected North American and European cities, taxi operations will

forever be an increasing cost industry, perpetually requesting rate increases due to inefficient and largely ineffective operations.

Given the lack of these new technologies, taxi operators are ill prepared to face competitive challenges and rates will continue to escalate, making alternative forms of transportation such as private car sedans, vans, limos, and car rentals, more economical to use.

Modernization would require investment in newer available technologies but not an unreasonable investment considering the benefits derived. Additionally, the costs of these new technologies have dropped dramatically within the past few years while the operational features and reporting capacities have greatly expanded.

For an investment estimated to be between $1000 to $1500 per vehicle, taxis could have electronic meters, GPS tracking and verbal directional driving information, computer dispatching, instant credit card swipe, electronic fare deposits and toll road/airport/seaport fee payments. Taxi drivers and users could have GPS shortest route to destination service, improved personal safety, greater payment flexibility, and accurate productivity per taxi information.

Taxi firms could choose to adopt a "pay as you go" method to acquire modern taxi technology; some of these firms offer total packages costing between $40 to $50 per month per vehicle. While this approach may be more expensive over a five-year period, the advantage is that little upfront capital is required since the equipment is leased from the technology firm. Another advantage is that the equipment and

software to support such an integrated taxi management system is maintained and upgraded by the technology firm.

An added benefit of such technology would be to make the task of taxi regulation much more informed and relatively easier. Many of these newer technologies provide for electronic capturing of all taximeter activity including actual trips dispatched per hour per vehicle and trips per day per vehicle (including personals) as well as geographic area served. Service times and availability of services information would also be available.

There are several firms operating in North America that offer these types of taxi technologies. A representative sample can be found at the following sites:

www.digital-dispatch.com

www.mobile-knowledge.com

www.TranWare.com

Similar systems have been developed, and are in widespread use in most other locations, and are exampled, in the UK, by Autocab, Zingo, and similar software. Significant advantage arises from use of planning software in allocating work to available vehicles close to intending passengers. Benefits arise to the passenger, reflected in the lower waiting times, and to the taxi drivers as a result of shorter driving distances while empty. Most systems operate on a zonal basis, allocating jobs by zone or proximate zone. Several of these modern taxi dispatch technologies utilized in North America are discussed more fully below.

5.2 Dispatch Systems

The most apparent uses of technologies relate to the optimization and automitation of the dispatch process, first discussed in Chapter One. Dispatch taxis respond to calls requesting transport, with job allocation from a central point, typically a taxi call centre or a TOA. The application of a technical tool for locating and allocating jobs greatly increases the efficiencies of this form of operation.

5.2.1 Experiences in the US

A major player within the US market is Digital Dispatch Systems (DDS), one of the world's leading taxi dispatch hardware and software companies. Its key product, PathFinder, is typical of the range of dispatch systems intended for taxi operations of 100 or more vehicles that wish to speed up their order taking and significantly reduce both the workload of taxi call takers and dispatchers, and the number of orders that must be processed by a human telephone operator. Its Automated Calltaker system for example, allows repeat customers who are already in the taxi company's database to create their own orders, utilizing touchtone phones. This is especially helpful for busy receptionists, hotel, and restaurant personnel who have little time to wait on the phone to speak to a call taker and order a cab. Often several cabs may be needed and the Automatic Calltaker can handle these multiple cab orders as easily as a single cab order.

PathFinder utilizes a number of hardware and software systems to tie together the mobile radio, GPS, taxi meter, scanner, and printing capabilities within the taxi, electronically to its base PathFinder Servers, which can process information from call takers to/from taxis instantly.

DDS software utilizes a number of its Mobile Data Terminals or MDTs with its PathFinder system. These MDTs permit the taxi driver to communicate with his system to receive trip details, process credit cards, and to both speak to and text their supervisor should any problems arise.

Similar to other sophisticated taxi dispatch systems that utilize GPS, PathFinder software groups the taxi service area into areas known as taxi zones. These zones are then utilized to keep track of all taxis on a real time basis to determine which taxis are available for service. Depending upon the service rules of the taxi operator, if the software sees that a particular taxi is the closest to the request for service, it sends an electronic message to the screen in that taxi for the driver to either accept or reject. Usually the driver has but a short time to accept or the system automatically shifts the request to the next closest taxi.

Alternatively, the system can be set to identify which taxicab has been in zone the longest time awaiting a trip and offer the trip to this taxicab driver first. Finally, there can be a combination of both systems which takes into account the distance from the pickup and the time a cab has been waiting by having the computer add a penalty factor to distance from pickup. If there is no taxi in that zone under either rule, then

adjacent zones are queried to determine where the closest taxi is or the one that has been waiting the longest.

Another aspect of such systems is the desire to speeds up the process of call acceptance and increased customer service. This is achieved by DDS using callout software to notify the customer about their specific taxi number and, depending upon software setting, alert the customer of the approximate time their cab will arrive for pickup. Such systems may also provide turn by turn directions to the driver should he/she need directions, and may be programmed to automatically phone the user with a recorded message that the taxi is arriving and will be available within a prescribed number of minutes, thereby minimizing wait time for the taxi and eliminating doubts by the customer that a cab has been dispatched for them.

Electronic means of transferring data also prevents the poaching of taxi trips by making it extremely difficult for other drivers to obtain the pick up data. Additionally, the customer is more likely to take a specific cab number that has been assigned rather than one that may be from another company or even a different numbered cab from the same company.

This electronic screen may also be viewed as a safety device when compared with the use of a handheld microphone or telephone. Mobile Data Terminals today display easy to read data on much larger screens than any cell or handheld phone, so information is communicated with significantly less distraction for the driver. In some states, California for example, there are statewide laws which forbid the use of handheld cell phones while driving.

PathFinder's™ main menu offers a variety of preprogrammed reports that can greatly assist the taxi company management in knowing more about their fleet operations and thereby, managing much more effectively. Being tied into DDS's electronic taxi "smart meter", having GPS, and an electronic record of all trips allows taxi company management to know significantly more about their operations. Taxi management today has the ability to obtain all fare information from all cars. They can spot drivers who habitually take a longer route. They can determine which drivers are working their radios, sitting at the airport, or primarily serving only one or a few areas of the city.

Good taxi operators may also find Over-Booking features helpful in managing customer service levels. This feature allows the taxi system manager to set the maximum number of trips their company may accept or schedule in a particular zone, area or system wide. Obviously this prevents the taxi company from bookings they have little or no chance of being able to carry out.

Electronic systems provide taxi system managers with the general ability to manage the activities of their drivers with respect to time permitted to drive, record keeping of driver accounts, settling driver credit card accounts, and keeping tack of driver activity and capacity of their system. The System Manager can run reports indicating the number of trips per day, week, and month; by driver, by zone; by hour and day, etc., or just about any way one wants, in order to obtain summary statistics that may help in running the operation, setting driver lease rates, providing accurate detailed trip and financial data to third party payers, or reporting activities to regulatory

authorities. Additional functionalities permit taxi companies to specifically oversee the individual actions of their drivers and customer service on a daily basis. By utilization of GPS mileage, call takers can more accurately inform customers of the approximate cost of their taxi trip. The computer also keeps track of routes taken and may be set to flag trips that are considered out of route trips by individual drivers. Depending upon the parameters set by the system management, the computer stores this information for a period of time so issues of lost articles can be traced back to the individual cab and driver.

Driver actions can also be electronically monitored by having the computer flag quick meter turn on and off for a specific pickup which may indicate that the driver is providing service "off the meter". Alternatively, the computer can spot circumstances where a meter is left on for a preprogrammed trip. Storage of all trips for a period of time can assist police officials if a crime has been committed and a taxi was utilized to as a means to leave the area. Finally, such software modules permit taxi companies that have a need to share ride or group ride individuals to do so, designing the optimum route, fare calculations, invoicing of client(s), and payment of driver if desired. This system is also capable of doing the same for additional transportation offerings a taxi operator may want to have as additional business units. Sedan, limousine, bus, or shared ride van operations are only a few of the different service options.

For smaller taxi firms that may operate in smaller communities or those not able to afford the complete suite of hardware and software systems for larger users, a number of internet booking services exist, such as TaxiBook.

According to their promotional literature, DDS TaxiBook is:

"Designed for taxi companies whose economies of scale do not justify the use of a full scale enterprise solution, Digital Dispatch's internet taxi dispatch service, TaxiBook™, is offered as a bundled package. This offering is a subscription-based monthly service that addresses the needs of smaller taxi companies which comprises a substantial yet relatively under-served market. TaxiBook™ service includes dispatch functionalities, airtime for data communications, in-vehicle mobile data computer, automatic vehicle location and electronic payment. Taxi companies can access the system's server computers from anywhere in the world using a PC with broadband internet connection and a web browser." (See: www.digital-dispatch.com)

Using this "pay as you go" system provides many of the same capabilities of the more sophisticated system described above but offers the smaller taxi operator the opportunity to pay for the system as it is utilized.

Taxi fare payment systems are also changing as a result of these advanced hardware and software solutions are being added by taxi companies. Many taxi users today want to pay for their transportation service by credit card and receive receipts for reimbursement by their companies or for their personal business expenditures records. Credit card acceptance has been gaining in popularity and many North American taxi regulators are adding acceptance of these cards as a mandatory service offering of the taxi firms they regulate.

However, accepting credit cards and processing them quickly and efficiently are completely different things. If a taxi firm is small it may be using a completely outdated open channel radio system. An independent owner-driver may use his cell phone as his dispatch system, the driver reading out the patron's personal credit card number and PIN over an open radio channel or a cell phone, as was the practice by some when credit cards were mandated not a pleasant passenger experience. Even the current practice by many North American taxi companies of using the old "knuckle buster" portable credit card slide machine, is tedious and time consuming when the driver must dial or phone in a credit card for approval.

Here again, taxi technology, far ahead of standard practice in North America, is coming to the rescue with devices that provide quick electronic checking of credit cards and print a receipt for the taxi fare. DDS's SmartPay is one of these systems.

"DDS, through use of DDS SmartPay, offers all users of their systems the capability to process customer credit and debit cards for trips using Interac Debit Cards. This mobile card swipe terminal offers both quick processing of accurate credit card information, credit availability, and printing of customer receipt. This system can also summarize credit/debit card information and send invoices to commercial or social service users of the taxicab system." And, firms like DDS do not intend to stop advancing their payment options for the customer. As depicted in the firm's latest promotional release, "A current addition to this (SmartPay) capability is the extension of its use to mobile media usage or cellphone payment for taxi services. Cellphone users can pay their taxi fare online and receive both an electronic and immediate paper receipt if desired."

Thus, the businessman or woman who travels a great deal will no longer have to keep detailed receipts and business records of taxi, sedan, towncar, or limousine expenses. They will be electronically transmitted and if he or she has personal software, grouped with regular business expenses.

Mobile Knowledge:

Taxi, Black Car and Limousine

Another well know computerized taxi dispatch system in North America is Mobile Knowledge which provides turn-key enterprise-wide systems using the latest technology to solve the needs of the taxi, black car and limousine industry. Headquartered in Toronto, Canada, this taxi oriented company has over 160 installations worldwide and their systems dispatch over 50,000 worldwide daily. As per their promotional materials, their systems are, "Improving service through dispatch automation and the speedier exchange of information between drivers and the dispatch center."

Since the early 1980's, mobile Knowledge has been well known for its hardware or Mobile Data Terminals (MDT's), and its work with taxi fleets. The firm was developed to utilize computer solutions in the dispatch, and later tracking and office management of taxicabs. (See: www.mobile-knowledge.com)

Mobile Knowledge considers itself to be the world leader in GPS-based vehicle location tracking and telematics systems and its Series 2000 MDT has seen

widespread use throughout North America and other parts of the world. However, its latest introduction, the Series 2008 Mobile Data Terminal is considered to be a state-of-the-art taxi MDT.

According to Mobile Knowledge, "The Series 2008 MDT is the most advanced MDT available on the market. Equipped with a 50 channel GPS receiver and 2 USB ports, drivers can download their trip information to analyze on their home PC with Mobile Knowledge's FarePlay software."

Similar in software solutions offered by DDS and others, Mobile Knowledge is attempting to also provide software to the independent taxi owner-driver that they can utilize to manage their individual operations. One of their objectives with the Series 2008 MDT is to completely eliminate the use of voice communications unless there is a problem and to improve driving safety by setting their terminals closer to the field of vision of the driver. The Series 2008 MDT also has a panic button which, connected to GPS, allows authorities and other cab drivers to know immediately if a driver is having a problem with a passenger.

Finally, Mobile Knowledge has pioneered the use of back seat taxi credit cards coupled with television and advertising to pay for the variable cost of installing these added features to taxi payment systems. Installed in some New York Yellow Taxis, these new credit card payment systems have proven to be very popular. For more information and informative videos including taxi company personnel testimonials on the use, efficiency, and effectiveness of these new MDT terminals, readers should

open their url at www.mobile-knowledge.com and download or view their promotional materials.

TranWare:

TranWare is a smaller taxi dispatch system but is utilized by many smaller taxi firms in the United States. Entry level costs for its products are generally lower than for many of its larger competitors. Its products are divided into two product lines: Enterprise and Desktop. As per their promotional materials,

"TranWare Enterprise Management Modules are designed for Taxi, Paratransit (non-emergency medical), shuttle and other localized ground transportation fleets. They are complete, configurable end-to-end management applications that can help you automate your Order Entry, Scheduling, Dispatching, Driver Cashiering, Customer Billing and Vehicle Maintenance operations."

TranWare attempts to utilize common business computers and existing software from Microsoft. All systems are designed for Microsoft Windows 98, 2000 Professional, XP Professional and Vista Business for the smaller taxi operator, Windows 2000/2003 Server, Windows peer-to-peer and Novell® Netware® network systems are also supported for taxi systems of larger size that need greater scale.

For the smaller limousine and Black Car (premium sedan) operators, even for those running only a few vehicles, TranWare offers its desktop software featuring WinLimo™. WinLimo™ is offered as a complete reservation, dispatch and management solution designed specifically for limousine and black car operators. As

indicated, WinLimo™ is ready to run a small taxi, limousine, or black car service for hire. The software includes modules for call taking, reservations, and trip/fare rating. This system also allows the small user to keep track of driver commissions and customer invoicing. WinLimo™ also provides that a history or their database from operation can be integrated into QuickBooks, popular bookkeeping software utilized by many small entrepreneurs and companies, thereby eliminating the need for double entry and post trip processing of the transaction. TranWare now offers cellphone taxi dispatch systems for taxi firms with as few as fifteen (15) vehicles.

5.2.2 European experience in dispatch systems

A similar experience is observable in Europe to that seen in the US. Moves to computerized dispatch systems, many using GPS are widespread. In a number of locations combined schemes exist including systems that automate passenger location using cell phone GPS coordinates in addition to those using vehicle GPS. Some locations may also choose to use single dispatch centers, a practice being developed in Austria, Finland and in some UK cities, distributing jobs across competing taxi companies.

Dispatch systems may be classified to include (in broadly descending order):

Single systems responding to booking across a city allocated to multiple suppliers, sometimes called a booking agency

Single systems responding to booking across a city allocated to company subscriptions

Multiple systems in competition responding to bookings across a city allocated to company subscriptions

Multiple small systems in competition responding to local bookings allocated to company subscriptions

As booking technologies expand the range, or reach, of a dispatch company, an increasing use of citywide or wider agencies becomes possible.

Single city systems are observed with increasing frequency, where an individual company, or main dispatch centre operates bookings across the entire city (Oslo Taxi, Glasgow Taxis etc.). The nature of taxi ownership is well suited to a single agency responsible for trip distribution amongst multiple operators, either as the sole dispatch system, as is the case in Glasgow, or as a routing system for a collection of dispatch centers. In other locations, including Edinburgh, Belfast etc., a number of competing dispatch centers each offer their own services. In the case of the UK limited opportunity for price competition exists, leaving the main differences of quality competition, and perceived reliability of one radio system over another. Equally, as the actual levels of delay (quality of service) depend on the number of available vehicles for hire, downward price competition exists to taxi drivers in choosing between one company and another.

A number of technology companies offer taxi dispatch systems in the UK. Many of the systems themselves offer the same functionalities including booking and automated dispatch. Autocab (www.autocab.com) is one such company.

The key facets of the Autocab, and similar companies' systems are:

Booking and Dispatch

GPS Vehicle locations

Interactive voice command

Accounting and driver accountability

The booking and dispatch functions receive and map customer requests for journeys (origin and destination) and allocate, or offer, journeys to the most appropriately located taxi.

GPS, currently mainly allied to the real time location of the taxi, allows for the determination of the most appropriate vehicle, usually in the basis of proximity. Drivers, equipped with terminals in vehicle, are able to indicate their availability and status, whether available for bookings, on a break, or carrying other passengers. Some systems allow for the approximation of job clearing time, the point that an engaged vehicle is likely to become free (including the location at which the vehicle will become available), and providing an additional variable to determining most appropriate vehicle for allocation.

In vehicle equipment allows for the identification of location, display of jobs and for the driver to set their status (available, on break, engaged etc.). Additional functionalities may also be added, often allied to the increasing ability to transmit large amounts of data between vehicle and land base, to include security cameras located within the vehicle, with images stored centrally. Additional functions include the transmission of credit card payments to a home base. It is possible that systems may also be used to account for (record) a driver's position, even metered fare. The provision of detailed passenger and driver behavior data may be appropriate for use in the instance of disputed fares or circuitous routes.

A further development of booking technologies includes the Zingo system (www.zingotaxi.com), which utilizes the GPS coordinates of a cellphone to inform the dispatcher (dispatch system) of an intending passenger's location. Though strictly operating within the dispatch market, a cross-over between dispatch and hailed modes is likely, in that the intending passenger effectively hails a taxi using the Zingo system. The system is part of a development of Location Based Services (LBS) that utilize GPS information regarding the location of a cell phone to provide information (and advertising) specific to the position of the phone. Similar concepts include a trial of LBS phone bookings in Oslo (www.oslotaxi.no) marketed as Taxi Direct. Internet bookings have also developed, being a logical extension of the dispatch system, and these are seen in the majority of European cities.

In Finland a system of planning taxis alongside other forms of demand responsive transportation (DRT) has allowed the combination of taxi journeys with those operating as transit, and in some instances paratransit operation. The Finnish company

Mobisoft (www.mobisoft.com), operates a transit planning system that includes taxis (Mobirouter), and a taxi stand alone system (taxi book).

The use of multiple operator agencies also increases the opportunities to engage taxis and similar vehicles in remote locations, and this has been the basis of development in rural transport, see Chapter Eight, and including transport to employment (www.t2e.org).

5.3 Data Utilization by Taxi Regulators:

Regulators of full service taxi firms which utilize these modern taxi dispatch systems can request far more detailed information from their regulated operators to better evaluate current levels of service, the overall health of their taxi systems, and the need to adjust the number of taxi permits required by their communities. As previously shown in Chapter 4.2.3 Regression Analyses, such detailed data can be utilized to determine service times for all geographic areas served by the taxi firm – not just an average for their system or a limited analysis of in city center and all other trips. However, the same data streams captured by smart electronic taxi meters can tell managers and regulators much more about how the taxi system is operating.

Examples are hours of work, days of work, and trips per shift or day per driver. The value of such data can best be illustrated by a recent case study of taxicab operations in Winnipeg, Canada. Shown below is data from a large taxi firm (association) in Winnipeg, Canada that currently maintains its database on dispatched trips only.

This view of the firm, coupled with zip code or zone data discussed in Chapter Four allows the regulator the opportunity to determine that service times are good and that capacity of the current taxi system is quite capable of meeting this summer or off peak need of its community. Since, taxi service is a derived demand, i.e., few people call for a taxi just because they want to ride – they actually call or hail a cab because they want to move from point A to point B for some reason. Adding more taxis would not stimulate demand if the current demand is being met reasonably well; it would only decrease the rides per regulated taxi thereby making the system and drivers incomes less efficient and effective.

Call customer wait times can also be displayed from dispatch data as shown below, often dispelling urban myths and uninformed newspaper editorials that it "takes forever in this town to get a cab."

(Insert Image: Figure 5.3)

Figure 5.3 Wait Time Distribution

As depicted, the Winnipeg Taxi Association has an excellent response time. Sixty five percent of callers to Duffy's Taxi are picked up within 10 minutes across its citywide system and nearly 90% completion of calls for service within 15 minutes – good results for any taxi call system.

A more in-depth appreciation can be determined from breaking this waiting time data down by individual zones, as depicted below for Winnipeg's zone 100 – the primary service area (downtown) of Duffy's taxi.

(Insert Image: Figure 5.4)

Figure 5.4 Average completed Taxi Trips per day

As shown, taxi call service averages between 5 and 6 minutes with nearly 90% being completed in 10 minutes or less. Data that can easily be utilized to dispel any complaints about poor taxi service or the need for additional taxis – at least during this time period.

Such data can also be utilized to check for the need of additional peak time taxi permits for special occasions or even weekend taxis where there may be spot demand for taxi services on Friday or Saturday evenings as people go out for dinner, night clubs, and bars. Shown below is the same taxi service by peak hour on peak evening.

(Insert Image: Figure 5.5)

Figure 5.5 Wait time during peak hours

As shown customers who call for a taxi have a longer wait – now less than 60% of callers are serviced within 10 minutes and the tail of the distribution is more spread out indicating people do wait longer during this peak evening period. But 97% of the callers are picked up within 20 minutes suggesting that even during these summer weekend peaks, there is no need for additional taxi services.

Such utilization and customer wait time data can also be utilized for seasonal variation. Below are total trip data per shift (dispatch, stand, and hail trips) from another Winnipeg taxi firm that depicts the trip activity during a winter day in Winnipeg Canada. (February 8th, 2008)

(Insert Image: Figure 5.6)

Figure 5.6 Distribution of Total Trips

As shown, taxi utilization nearly doubles during the winter season of Winnipeg, Canada. The taxi company depicted above was able to only complete 40% of the calls they received that day – a typical winter day in Winnipeg. Windy conditions with temperatures dipping below minus 20 or 30 degrees Fahrenheit, are common. Automobiles need to be "plugged in" to electrical outlets for their engine block heaters. All buildings, airport parking lots, and public parking spaces are required to have such plug ins are viewed as simply part of the cost of providing the parking. Thus, many Winnipeg residents utilize taxis as a way to move about in the winter season. Estimates are that approximately 50% of the population utilizes taxis to some degree during these winter months.

From this type of data analysis, it is obvious that Winnipeg requires more taxis during their winter seasons but not during the summer. Thus, Winnipeg taxi regulators have a database from which to make these decisions instead of the traditional letters from users saying their current service is poor, that they will utilize additional taxis, and other antidotal indications about the current taxi service and the need for more

service. From these types of data bases, taxi regulators can make much better decisions on both the number of taxi permits needed by their community and the times or seasons they are needed.

Another data point that can be gleaned from electronic dispatching systems is the relative efficiency of taxi call centers. As shown below, the relative success rate of filling calls by our Winnipeg Taxi Association can be clearly calculated and displayed.

From these detailed statistics the taxi company and the regulator can work on reasons why nearly 15% of the calls end in the trip not being completed. If it is as most suspect, that some users call several taxi companies and simply choose the first one to show up, these callers can be first warned of their behavior and then shut out completely by the computer which does not accept an order from that phone number or individual.

5.4 Implications for Taxi Regulators

The availability of modern taxi dispatch/payment technologies and software by no means insures that taxi companies and drivers will employ them – especially the smaller taxi firms and independent owner operators that have little or no radio/electronic dispatch affiliation and desire to maintain their complete independence. Therefore, if local taxi regulators wish to have their communities

enjoy the benefits of more efficient taxi operations, driver tracking for most economical routes, enhanced recovery of forgotten articles, payment options, right sizing of their taxi fleets, and just more management of the driver-passenger interface, they will most often have to require it. Much the same as mandating taxi meters, age of vehicles, and credit card acceptance, taxi authorities will have to require reporting by taxi firms and individuals that require the use of these modern computerized taxi dispatching and payment systems.

The modern taxi dispatch, driver management, and payment systems discussed in this chapter are by no means exhaustive and there are others that could meet all the reporting and dispatch requirements of local taxi regulatory agencies. Their requirement would greatly improve the taxi company's ability to compete and maintain fares as low as possible and, as previously stated, allow the regulatory agency a much more comprehensive look at how each of its regulated taxi firms was performing, what areas and or markets they were serving, the activity of their drivers, and economic performance of their systems. Such would vastly improve the regulator's ability to regulate in the best interests of the public.

Central dispatching by modern taxi dispatch systems is also extremely beneficial to the advancement of Americans with Disabilities Act (ADA) goals in mainstreaming people with physical disabilities into the taxi system. By having central control and dispatch with GPS capabilities and electronic capturing of trips taken, taxi companies are better able to integrate these trips into efficient taxicabs with wheelchair accessibility appropriate or required, and provide the electronic proof and invoicing often required when public funds are involved.

One final note, the obvious conclusion, that a cell phone network is not a modern taxi dispatching system. It may be fine for limousine and personal car services when customers are arranged in advance and operated as a one on one basis in small-scale operations. Also, certain cell phone systems can now be utilized for GPS directions and, as noted, for prompt credit card processing and even the printing of a customer receipt. But as a network system operation, these small "spider" cell phone systems fail to offer the efficiencies of a true taxi dispatching system. Regulators should not be lulled into believing that a taxi company can be run with just a cell phone communication system – much more is needed and should be required.

5.5 Conclusion

As shown by this section, the evolution of modern taxi dispatch technologies has helped to shape the taxi industry over the past eight decades, allowing it to potentially become more efficient and effective in serving the public's need for low cost and efficient privately provided public transportation available at all times of the day or night. In today's competitive environment, the traditional taxicab stands to price itself out of numerous markets unless it can take advantage of modern dispatch technologies which significantly reduce deadhead mileage, increase density of coverage, and maintain vehicle productivity to its highest levels.

As pointed out, taxi regulators need to become more familiar with the capabilities of these newer taxi dispatching systems, require their utilization, and then regulate based on the actual data provided by these systems. Perennial questions and endless debates about the extent and quality of service as well as the efficiency of existing taxi services and even proposed taxi permits can and should be answered using actual operating data provided by these systems instead of archaic economic theories and antidotal letters of support. Regulatory authorities need this data to intelligently determine the proper number of taxi permits to authorize. They also often need this data to dispel public misconceptions about current taxi services and to patiently explain to elected or appointed politician's why there is either a need for more taxi permits or more often, why there is no need for additional permits.

Chapter Six: The role of the taxi in Night Time Economies

Introduction

It is directly observable in many cities that the use of transport differs by time of day. Rush hour commuting focuses on distinct peaks in demand often based on common work patterns, with differing uses of the city in evenings, night times and weekends. The Night Time Economy provides differing opportunities and presents significantly differing challenges in comparison to the day. In transport terms, demand differs across time periods reflecting particular advantages or preferences for one mode over another by time of day, with examples of "modal advantage" including speed, availability of terminal/parking and terminal proximity to origin/destination which, again, will differ by time of day.

This chapter looks at the role of the taxi in the Night Time Economy (NTE), particularly as it affects larger urban areas, the issues perceived and observed in use of the city overnight, and the development of solutions to increase accessibility to taxis including new and innovative uses.

6.1 What is the night time economy?

In its simplest definition, the NTE refers to all economic activities during night time hours. While it is common to discuss city activities as generic, a distinct and sometimes distinctly different set of activities is identifiable at night, compared to daytime patterns. The NTE thus relates to the extended social and business activities beyond a traditional daytime pattern and is most commonly identified in relation to city economies. Contemporary city literature (Thomas and Bromley, 2000; Civic Trust, 2006) suggests that the ability of an urban society to function at night, as well as during the day, is seen as a positive – the contribution of night time activities to the city economy as a significant plus, developments of which are sometimes referred to as contributing to an urban renaissance. Such activities, however, present a potential for negative impacts including "spill over" activities intruding into residential environments, and potentially adding noise and in some instances contributing to perceived and observed conflict, (Roberts and Turner, 2005), actual or perceived increases in the level of crime, and environmental impacts including noise and litter. The parallel emergence of conflict and fear in the evening and night-time city limits public trust, adds to perceptions of fear among individuals both those seeking to use, and those seeking to provide transport including taxi drivers (Gambetta and Hamill, 2005). Particular issues expressed by taxi drivers include personal safety, and passengers' avoidance of fares (Stenning, 1996). The presence of fear reduces the attractiveness of the location as a destination, and will ultimately threaten the activity of the city centre beyond the nighttime activities that have created it.

A number of reviews (Chatterton, 2000; Heath, 1997; Hadfield et al, 2001) make comparison between the activities of the city overnight and during the day, seeking to establish the extent to which a '24hr city' exists – where the same or similar activities

occur during the night as during the day. Others identify a city never sleeping as a goal of a cosmopolitan city, even being seen as attractors for tourism (Cooper, 2005). In reality, few cities actually manage to replicate daytime activities into nighttime hours, and those which do may see the development as an economic imperative, rather than a matter of social desirability[14]. More identifiable are a range of industries and activities maintaining 24 hour presence, or presence specific to the nighttime economy, ranging from business services in US cities (e.g. FedexKinkos) to the entertainment, eating and drinking apparent in the UK and worldwide.

Societal constraints, most specifically the concept of 'normal behavior', also act to reinforce a day/night split of particular activities occurring at specific times, suggesting that the concept of 24 hour office work is unlikely to be a significant part in most western nighttime economies in the foreseeable future. This, however, does not preclude the growth of the NTE. Indeed the period from the 1990s has seen a significant growth in city centre activities; while increasing numbers of residential developments in city centers suggest an increased popularity of urban living (Myllyla and Kuvaja, 2005), characterized as the development of 'vibrancy' (Tallon and Bromley, 2004) in the context of 'urban renaissance'. Such vibrancy is, however, allied to new challenges – particularly related to alcohol associated disorder, and to new policy questions in relation to strains on public services, including transport (ODPM, 2005&2005a; Myllyla and Kuvaja, 2005), and a related fear for personal security (DETR, 1998). Against this backdrop, the relationship between taxi use and the nighttime economy is significant.

[14] Examples of this may include "offshore" service economies operating within the daytime hours of a client in a differing time zone. This is a common approach in computing services provision.

6.2 The role of transport in the nighttime economy

Transport plays a significant role in the development of the nighttime economy, and is equally impacted on by the success, or otherwise, of nighttime activities. The availability and attractiveness of services are significant to the choice of destination as is the extent of access available.

In reality, both transport, and the activities of the city facilitate each other. With few exceptions transport exists following historical patterns and has developed over time. In many cities transport has played a role in the form of the city itself. Transport facilities and design, are thus influenced by the form of the city, are dependant upon the pre-existing conditions of the city (legacies from previous planning and transport policies) natural and physical restrictions.

Market influences affect the provision of transport as much as policies themselves. The extent to which transport acts to facilitate the city reflects the market for services, perceptions of cost, reliability and safety. Differing identifiable markets exist across the range of city interactions, being time based, spatially restricted or influenced by the economic circumstances of their current and potential users.

Distinct differences in transport markets exist by time of day, with typical bands being defined as:

- Daytime am peak

- Daytime between peaks
- Daytime pm peak
- Early Evening travel from entertainment
- Cusp / mid evening
- Late Night

The exact preference for particular forms transport and the relationships between time of day and modal advantages will vary between locations. It is however, appropriate to identify that differences do exist and these have tended to gravitate to taxi use at night. This is logical, as the mode continues to operate across all time periods, including those where other forms of transport have closed or operate a lower level of services compared to the daytime. Taxis may also be seen as a more dependable mode and, in some instances, safer than using night bus or similar late night services. This remains a distinct influence even where actual personal safety is better than its perception. Distinctions can also be drawn between the types of activity typical by time of day and broad assumptions about majority passenger type. Later night activities tend toward entertainment and drinking which contribute to and reinforce the view of drunken behavior by this group.

In order to fully understand the demands of the nighttime city we first need to define the use of transport at both day and night, and the policies affecting both periods.

6.2.1 Daytime City

Insofar as most transport policies make no reference to a specific time of day, or indeed particular seasons, most appear to identify issues pertinent to the operation of the daytime city. This is also the case for a majority of policies, with some particular exceptions, originating from other Central Government departments.

Objectives typical of transport departments are summarized by Llewelyn-Davies (2004) as seeking to address the impacts of congestion and pollution on 'urban attractiveness', reduce delay, enhance inclusive transport and enhance competitiveness. Although at the highest levels, many of these objectives merit attention in both day and night time economies, the majority of policies remain consistent and visible in the daytime city, with recent examples including congestion based charging, and parking restraint.

Transport in the Night Time Economy remains, and indeed has increasingly become, separate, subtly different and wholly inconsistent with the more straightforward supply in daylight hours.

6.2.2 Night Time City

The nighttime economy differs significantly in the range of facilities available, modes of transport available, and the ways in which transport is used. Differences are also visible specific to the locations within the city from which travel is originating, and the environmental conditions in which travel is occurring. In many instances, private

vehicle congestion typical in the daytime city is replaced by significant peaks in the demand for public transport modes, and specifically use of taxis late at night.

Patterns and extent of peak demand, even the popularity of modes of transport differs as the night progresses, being dependant upon the activities being undertaken, the availability of differing modes, and the extent of drinking. Later nighttime transport is heavily skewed away from private vehicle use.

As the motives, needs and preferences of the nighttime economy move away from those of the daytime city, it would appear logical to determine policies according to circumstance and activity. Interactions within the NTE also provide a focus for the determination of policy application, establishing the differences within the nighttime city as an element in the determination of policy direction, and establishing methods by which negative conflicts between policies, and within policies applied in differing circumstances, may be avoided.

6.2.3 Activities in the Night Time Economy

In the nighttime economy, competitiveness of the city is replaced by the relative attractiveness of its facilities (central compared to suburban facilities or those in nearby towns) going out activity compared to staying at home entertainment. Additionally, night time activities are more likely to be based on discretionary spending (non-essential expenditure), with choice of activity not simply a choice between which pub or club, but also whether to go out to entertainment at all,

compared to the relative obligations of attending employment, or non-discretionary expenditure, typified by food shopping etc.

Participation in the nighttime city can also spread across a wider range of activities than immediately apparent. Whilst perceptions tend to highlight drinking as a predominant activity, most cities experience a range of other social and economic activities through the evening and night. Activities in the early and mid evening tend to differ from those later in the night, with Theatre, Cinema and Restaurant activities, tending to differ from the heavy drinking activities of those in the early hours of the morning.

Activities occurring at the cusp of the nighttime are also more likely to include use of private transport – participants being less inclined to be drunk, and less likely to be influenced by drink driving campaigns

Interactions in the late night economy are facilitated by, and rely upon, the ability of the individual to access and participate in its activities. Public transport is integral to this activity as, in the absence or unwillingness to use individual private transport, it forms the basis for the mobility required to participate. The widespread use of anti drink-driving laws, particularly their aggressive application in Europe, has further acted to contribute to taxi use at night.

6.3 Potential for conflict in the NTE

Given that the use of a city varies significantly between time periods, it is appropriate to identify the particular circumstances in which nighttime transport is provided. Potential for conflict exists, and can be identified, in relation to both the use of transport and in terms of the policies applying to transport provision. The former contributing to fear of use and ultimately affecting the latter, the latter impacting on the constraints in which transport is provided.

The issues of behavior and personal interactions within the nighttime economy (see: London Authority, 2007) are detailed in section 7.3.1, below. It is appropriate to consider the interactions and conflicts between policies affecting the NTE. A survey of UK local authorities15 suggests four areas of potential policy conflict exist being:

- Differences between daytime and nighttime impacts of the same policy,
- Conflict between security and a welcoming transport environment,
- Different locations within the city for day/nighttime activities, and
- Boundary and institutional conflict.

These are further explored in section 6.3.2.

6.3.1 Personal interactions in the NTE

[15] Completed by the authors on behalf of the UK Department for Transport (See: Cooper, 2005)

Use of transport during the night is directly influenced by its availability and perceptions of safety, security etc. Table 6.1 is derived from a survey undertaken across 52 local authorities in the UK[16] and highlights the interactions specific to transport. Interactions include adequate and timely supply, but are also identified in relation to secondary interaction, including the impacts of the environment on use and relationship between use and perception.

Table 6.1 Interactions felt significant in the use of transport

Focus	Interaction	Secondary Interactions
Interactions specific to transport	Private / Public transport modal split	• Time of activity • Public transport schedules • Drink Driving • Quality of services
	Commercial and non-commercial transport operation	• Assignment of resources • Involvement of retailers / licensed trade
	Supply of public transport and taxis	• Impact of Unmet Demand • Quality and Quantity controls of taxis • Illegal and grey markets for taxis
	Provision of adequate Security to those travelling	• Perception and reality of vulnerability to attack • Access to boarding and alighting points • Waiting Environment • Security on vehicles
	Role of staff	• Reassurance • Enforcement • Policing • Operational Control

Source: Author, survey of 52 authorities

The impacts of differing perceptions on use are also significant, and can be identified across a wide range of NTE activities (Tierney, 2006). A scoring system was devised within the survey whereby issues were ranked in order of importance highlighted. From the 52 authorities responses received the main three areas of concern were:

[16] Cooper, 2007

violence, drunken behavior (and crime arising from the consumption of alcohol) and a lack of transport.

Drunken behavior was identified as significant both in terms of the problems arising at night, and in relation to policy application, where policies set a pattern to be followed, while enforcement actually impacted on the environment and the success (or otherwise) of the policies. Policy effectiveness was also investigated, with Liquor Licensing policies being felt to have the greatest impact on perception of place, as well as the greatest impact on transport. Surveillance, including watch schemes, scored highly as having an impact on the level of crime, although more pro-active measures such as Anti Social Behaviour Orders (ASBOs) achieved a lower 'effectiveness' score and Acceptable Behavior Contracts less still.

The apparent lack of public transport was felt to be an issue, see table 6.2, though views of the significance of individual modes varied widely from city to city, often reflecting the differing levels of availability of transport between locations.

Table 6.2 Significance of issues identified specific to NTE

	Value (x/100)
Violence	72
Drunken behaviour	76
Lack of bus transport	71
Lack of Rail transport	51
Lack of taxi transport	60

Source: Author, based on responses of 52 cities

6.3.2 Policy conflicts within the NTE

As with personal interactions, the application of differing policies affects the operation of the NTE. Policies conflicts arise on a number of levels: policies arising in differing domains, exampled where a housing policy impacts on the need for transport; or where policies designed around the need of a city aimed at daytime transport provision inadvertently and negatively impacts on the provision of transport at night. These can be illustrated as conflicts arising within policies, and those arising between policies.

The main sources of conflict arising within policies refer to differences between their application in daytime hours, and that during the night (Temporal Resolution). Thus policies impacting on the daytime supply of transport may have a negative impact on the supply of transport at night. These are highlighted by transport mode below, and include impacts to public transport arising, in the UK, from the Transport Act 1985; impacts on taxi transport arising from licensing policies at a local level, and supply guidance at the national level. Additionally, differences in application of the same policies between neighboring local authorities may give rise to conflict (Spatial Resolution).

In addition to the conflict visible and resulting from differing needs at differing times of the day, interactions between policies may act to influence supply of transport, or transport impacting on the successful application of other policy areas.

Impacts arising, or predicted, in response to particular policies arising from other disciplines, are identifiable in terms of their impact on transport services, and are felt to include responses to Licensing initiatives, including those arising from the Licensing Act 2003; and impacts arising from policing, enforcement and safety initiatives. A significant amount of experience and commentary relates to the development of safety initiatives, and its impacts on transport are explored specifically in later parts of this chapter.

The 2005 review (Cooper, 2005) identified four areas where policy conflicts were seen as significant, summarized at the start of section 6.3, and set out in detail below.

The first conflict was felt to arise in determining and applying transport policies where differences between the day and nighttime impacts of the same policy exist. This might include road design or infrastructure intended to impact on daytime traffic conditions negatively affecting nighttime transport use. Examples may include signal phasing, circulation patterns etc. and may, in fact, be relatively easily adapted to nighttime use.

> Secondly; conflicts were identified arising as a result of mutually exclusive actions, such as high levels of security and the desire to promote a welcoming and inclusive transport. The physical architecture associated with security often presents a negative of frightening appearance. This is exampled by security barriers, bars between passenger and driver.

The third conflict identified arose from differing uses of the city, mainly related to the physical locations of day and night time activities differing, reducing the appropriateness of physical infrastructure across time periods. Although there is no direct conflict arising in providing facilities appropriate to daytime and to nighttime access to transport, other than competing pressures for finance, some of the current modeling approaches to taxi demand determination (see chapter four), treat city supply as universal – impacting all areas in the same way – rather than focusing on the demand needs temporally.

Fourthly, conflicts arise as a result of boundary conflict (both physical and institutional) including boundaries between the interests of differing departments and between department and local authorities.

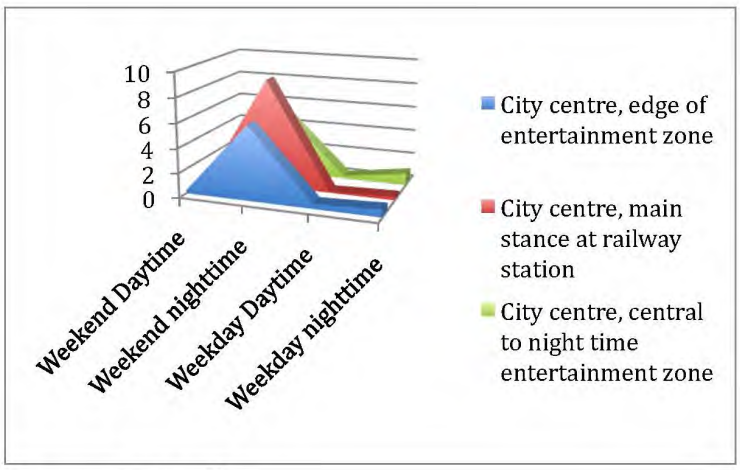
6.4 Night time issues in the use of taxis

We now focus our attention to the supply of taxi services in the nighttime economy. As previously identified, the use of taxis peaks significantly at night, as the supply of alternative forms of transport reduces, and reflect the reticence of many to drive with drink taken. While the increased demand for taxis at night is clearly a market opportunity, the nature of this demand, highly peaked at traditional pub and club closing times (see figure 7.x) also represents something of a challenge. Most specifically the extent of the gap between demand and levels of supply increases significantly through the

course of the night contributing to an extended delay in engaging taxis and frequent fueling the call for changes to the ways in which taxis are controlled.

Figure 6.1 Delays experienced in engaging a taxi (minutes)

Glasgow, May 2005



Source: Author[17]

The issue is highlighted in Glasgow, see figure 6.1, with its very sharp peaks in the demand for public transport occurring late at weekend nighttimes. The lack of supply at very specific times contributes to the discussion that restrictions on supply result in inadequate levels of service. An extension of this argument is that the removal of restrictions on the numbers of licenses will contribute to the extent of supply at points of excess demand. This is a complex argument, addressed in the modeling chapter (chapter four) and in later sections of this chapter. It is sufficient at this point to highlight the nature of the peak, rather than its resolution.

[17] based on 600 hours observation (Cooper, 2007)

Observations of individual cities is also helpful in identifying the extent to which taxi services impact on the wider use of the city and the relationships between traditional public transport (bus and rail) and use of taxis. Glasgow typifies a larger city in which a well-established daytime public transport system was accompanied by a far smaller nighttime service, and is common with many cities worldwide. The characteristics of such cities include:

- Mature public transit system
- Reduced night time provision of bus/rail services
- Identifiable night time economies including distinct entertainment areas centrally located within the city.

Larger cities may also offer nighttime specific bus routes and in some larger examples, including London, operate 24-hour bus routes. The difference is related to the fact that night buses tend to follow different and distinct nighttime routes, while the 24hour bus route remains the same at night as compared to its daytime service.

Observed issues in larger cities also relate to the relationship between different taxi types, which might include the black market for illegal, unlicensed, taxis and a grey market in which private hire vehicles ply for hire within the nighttime market. The latter, effectively illegal use of PHV taxis, can be observed as commonplace in some markets, and tolerated by authorities and particularly by the police where public safety concerns of moving people home quickly might outweigh licensing priorities to hackney carriages.

6.4.1 Catering for peaked nighttime demand

The majority of cities identify an issue in the supply of taxis as specific to particular times on particular days. In the UK a pattern of steeply peaked demand is observed at 1am, and again at 4am, matching departure from pubs and clubs to seek transport home. Fridays and Saturdays are identified as problem evenings, with the majority of demand outside these peaks being sufficiently well served. Such peaking leads to a conflict of interest between the need to address insufficient supply to meet demand on Friday and Saturday nights and the potential for excessive supply during the day. The dichotomy is significant and differing approaches n to address either issue can present problems. The issue of over-supply is highlighted in Dublin, in the Republic of Ireland where the removal of quantity limits applied to licenses, which occurred in 2000, has since resulted in a significant loss of income within the trade.

Spatial conflicts are also visible in some cities particularly, given the relative size of districts compared to their (larger) metropolitan areas, where neighboring authority taxis were felt to be encroaching, often illegally, on those correctly licensed and legally operating. Similar concerns exist in cities where PHV Taxis have operated as hailed taxis to pick up[18] illegally.

[18] An event referred to as "PU" by the Belfast taxi trade.

Measurement of and action as a result of significant peaks in demand at particular points in the weekend night time illustrate the extent of the relationship between night time and day time application of the same policy, insofar as licensing for a number of vehicles appropriate to the day time demand for taxis has often led to a shortage at peak night time hours; whilst the provision of taxis services sufficient to the peaks at night can, and arguably has led to decline in the service levels appropriate across the whole fleet. This argument continues between proponents of restricted licenses and those advocating the promotion of open competition, a stated preference of many policy makers rather than requirement or expectation (see Cooper et al. 2004, OFT 2003).

6.4.2 Use of Taxi Stances at night

Additional issues arise in the use of Taxi stances at night. Stances provide a focal point in the return journey from a city centre, particularly later into the night and, ideally, should provide a point from which an individual is able to engage a taxi with relative certainty. It is desirable that such locations are safe, and well served as appropriate to demand. The stance is thus a key location in the provision of taxi services at night and part of many journeys home. It is also observable in many locations that a stance can be a focal point for late night vendors and are subject to large numbers of individuals congregating, seeking to engage taxis.

The combination of large numbers of people, the sometimes significant delays experienced in waiting for a taxi, and the predominance of intoxicated revelers, late at night, has an impact on the perception, and actual levels of crime and inter-personal violence. Incidents at stance tend to be related to targeted theft, and disagreement specific to 'whose taxi', queuing formalities etc.

The stance offers both an opportunity and a challenge. The opportunity relating to a known and potentially secure location, challenges arising from perceptions and realities of personal safety.

6.4.3 Personal safety

A real and identifiable concern exists in relation to personal safety in the use of transport at night. Concerns exist in relation to attack and are heightened in perception, and in some documented cases, by the instance of drunken behavior at night.

In addition to the perception of risk in taxi users, taxi drivers concerned for their personal safety and the safety of their vehicles express a noticeable fear. In a survey of Glasgow taxi drivers 21% of all drivers expressed the feeling that passenger behavior was a factor that would affect their choice to supply. This rose to 53% of all night time drivers, suggesting a greater awareness or

caution in those drivers choosing to operate at night. A lack of drivers operating in the night time economy also heightens the issue of peaked demand, suggesting that overall numbers of licensed taxis may not be a prime concern in supply, rather an inability to persuade sufficient drivers to work at hours felt anti-social and dangerous.

A number of solutions have been developed seeking to improve levels of safety. Taxi Marshals, uniformed authority or taxi company officers, are in use and have become popular in large cities. The Marshal adds an element of policing at a stance and ensures a better departure pattern for vehicles. In some cities specific stances have been identified as safety zones, including Safe Streets and "Nite Safe" areas with increased levels of policing, security cameras and panic buttons.

6.5 Developing Night Time Taxi use

The desire to develop taxi use suitable for a vibrant nighttime economy provides a number of challenges, and a number of potential solutions. Nighttime economies in large cities contribute to the activity of the location and good transport provision is key to this development. The nighttime city reflects differing uses, and focuses on different locations within the city when compared to the daytime and it is significant that the provision of transport affecting one does not negatively impact on the other. Urban taxi provision at

night tends to focus on the movement of large numbers of travelers home in the absence of other forms of public transport, and will often focus on taxi stance engagement in large cities, with a focus on pre-booked service in medium and smaller locations. Concerns for personal safety are heightened within the NTE with an increased demand impacting on the delay in accessing taxis at points of peak demand.

The particular needs of cities together with location specific market issues have led to a variety of approaches aimed at developing night time taxi use. These relate to the areas of:

- Extent of taxi supply
- Safety in taxi use
- Relationships between taxis and other modes of transport.

6.5.1 Increasing nighttime taxi supply

In Chapter three we looked at the use of taxi models to determine taxi supply regulation, and applied this, in chapter four, to the issues of regulation particularly in controls applied to numbers of taxis. Chapter four highlighted the conflict, in controls terms, between controlling taxi licenses and ensuring an appropriate supply of vehicles. This is highlighted in the nighttime market given the extent of peaking within this period.

Two approaches predominate. The removal of licensing restrictions to encourage additional supply, and the application of on site measures, such as improved stance design. These two measures are not mutually exclusive, but tend to be adopted at differing ends of the argument between regulation and deregulatory thinking.

Two periods of deregulation exist, discussed in Chapter Five, namely deregulation in the USA in the late 1970s, and more recent approaches in the Republic of Ireland, the UK (OfT, 2003), EU, New Zeeland etc. More recent examples of deregulation have tended to demonstrate similar impacts, a rapid expansion in the numbers of taxi licenses available but a less positive impact on the supply both in terms of quality and actual levels of supply. This does not argue either for or against deregulation, but identifies a real impact of increased numbers of licenses on the total taxi market. Where regulation results in excess levels of supply genuine hardship may impact on a driver's ability to earn, and consequently on the quality of vehicles being offered. There is also a link between the ability to earn and regulated fares. Alternatives to a blanket increase in the issuance of licenses may include the creation of nighttime only or specified times operating licenses, an option considered in some cities (such as Calgary, Canada) to address seasonal peaks in demand.

The second approach relates to improving facilities allowing better use of existing facilities. This reflects the fact that many taxi ranks are either poorly designed, or designed as appropriate to daytime demand. Critical to this is the

ability of vehicles to access and egress from the stance without physical conflict. The adoption, in a number of cities, of a taxi marshal has been highly effective in achieving better at stance performance, and will also contribute to the perceived and actual levels of personal safety.

Allied to the facilities at stance, highway restrictions designed for daytime traffic management may not be entirely appropriate to nighttime use. In chapter three we highlighted the example of the Gordon Street taxi stance in Glasgow, where physical design and traffic signal controls impacted on the performance of the stance at night. Signal timings and similar control measures may be developed to differentiate between daytime and nighttime needs and thus contribute to the effectiveness of nighttime taxi provision.

6.5.2 Night time taxi zones

The development of night time taxi zones has also been developed in a number of cities. The zone, which can be seen under a number of names across the UK, and in other countries, effectively focuses taxi engagement on a smaller number of stances that can then be controlled more appropriately than possible across a larger number of stances. The move to a small focused number of stances at night is likely to occur naturally in any case, given that the locations for night time activities can vary from those during the day.

Night time taxi zones may also provide a focus for using taxi marshals, whose presence both provides assurance to the public and contributes to better taxi operations. These benefits relate to a better control of taxi departures by reducing the opportunity for delays as passengers enter a taxi vehicle. The Marshal may also reduce the opportunity for disagreement amongst intending passengers as to who was in line first. This reduction in passenger disagreement will in turn reduce the incidence of taxi "drive by" where a driver chooses to drive away empty rather than pick up a passenger who appears to be disagreeable. Evidence in US locations, and particularly at airports, suggest that marshaled taxis are also able to load and then egress from a stance into traffic more quickly than in an un-marshaled stance.

Observation at the Glasgow Gordon Street stance prior to Marshals being introduced (Cooper, 2003) led to the identification of "queue creep" in which a lack of queuing protocol led to the head of the queue moving along the stance toward the incoming taxis as the next passengers in line leapfrogged boarding passengers to get the next taxi. As the queue creep moved the head of the line along the stance, the effective capacity of the stance reduced. The occurrence of conflict and queue creep in the Glasgow stance has reduced significantly following the introduction of a Nite zone and marshals at rank.

The issue of unlicensed pick-ups has also been addressed in some locations, including in Belfast, where a strongly worded advertising campaign has been used to remind passengers of the dangers of using illegally operating taxis.

6.6 Conclusions: night time city use, transport and taxis

While it is apparent that the transport plays a significant role in the city across day and night time periods, it may be concluded that the Night Time Economy is broadly underplayed in the development of transport policy. The majority of policies affecting transport appear constructed to meet the needs of the day time city resulting in, at minimum, a potential for conflict. The reduced emphasis on the night time city can exacerbate the issues surrounding transport in the night time economy, particularly that of travelling home from entertainment.

The development of transport policies appropriate to the needs of all transport users is a significant factor in ensuring appropriate development of services into the future and facilitating economic growth and social interaction. The needs of a night time economy do not necessarily mirror the needs of the daytime city, and the danger arises that policies drafted to meet the needs of the daytime economy may fail to meet the aspirations of the night time city or, at worst, work against the needs of the night time economy.

Issues in the provision of daytime transport, most particularly congestion, access restrictions and a desire to promote certain forms of public transport are far less likely to apply with the same weight in the night time economy, where private car use is reduced, congestion minimal and most public transport unavailable. Equally, the delivery of transport as exists during the night may

not be appropriate to the needs of the day. It would appear beneficial to develop policies specific to the needs of night as well as daytime use of the city, and to ensure that transport policies being developed in one arena are positive to the activities of the other.

It is desirable therefore that transport policies take account of the full range of their impacts in both day time and night time economies. Tools are required, including a standard method of assessing impacts arising from policy application across temporal as well as spatial boundaries and establishing individual impacts as well as corporate effects. Wider policy interactions are also significant. The interactions apparent within the night time economy are not limited to the effects of transport on its environment (and vice versa), but include interactions between transport policies and those applying to other facets of the NTE.

Chapter 7: The Role of Airport Taxis in Airport Ground Transportation:

In this chapter we look at the role of taxis in providing access at airports. The taxicab will generally represent a sizeable proportion of the market for public transportation at an airport and be subject to specific controls that may differ from those applied in the cities served by an airport. Indeed, given that many airports are located some distance from city center, the licensing authorities and taxi controls at an airport may well be different than in the city locations they serve.

This chapter considers the experience of taxi provision at airports in North America, contrasting these with similar provision in Europe.

Introduction: The Early Years

Taxis have played a very important role in the delivery of airline passengers to and from airports since the beginning of modern aviation. After WWII and during the early 50's, as air travel was just beginning to overtake long distance rail travel in the U.S., most city airports were located in what was thought to be literally "in the boonies" and far away from city centers. Usually there was only one bus line with the regulatory authority to provide service between the airport and the city center and taxicabs had to be called at many airports at times when few if any flights were arriving. Airlines, through their agreements with airports would guarantee a minimum number of passengers

and/or subsidize local transportation between the airport or city center as a passenger amenity.

The taxi regulatory structure at this time, as previously discussed in Chapter Two, was traditional in that only one or a few taxi companies typically had the operating rights to serve the airport, and as a result there was considerable bargaining power by the taxi operator in setting the terms of their service.

As airline travel grew greatly in popularity after the introduction of jet aircraft and the ability to fly over white knuckle weather patterns at significantly faster travel speeds, airports became sought after origins and destinations for both bus and taxi operators. What was once considered an out-of-the-way place became the single largest generator of individual taxi trips in many communities. At the same time many communities were deregulating their local taxi companies, encouraging new firms and operators to enter the market. These two events, the tremendous growth or airport taxi demand and deregulation of taxi services, completely reversed the relationship between the airports and their taxis.

Taxicab drivers were more than anxious to serve the airport customers with their typically longer trips. Airport taxi stands, previously vacant most of the time, were now overflowing with taxicab drivers wanting to queue up for arriving passengers, so much so that airports had to develop taxi holding lots for excess cabs that could no longer fit into the curbside spaces allotted to taxis.

Another event, which also contributed greatly to the creation of an oversupply of taxis at the North American airports, was the development of the independent contractor driver within the North American taxi industry. As previously discussed in Chapter Two, the fragmentation of the taxi industry through more, smaller, and even single vehicle taxi companies, drove the industry into the almost exclusive use of independent contractor drivers in order to remain competitive. Independent contractor drivers became the norm for both taxi company owned taxis and later for owner-operated taxis. Many independent taxi drivers, having opted to have little or no affiliation with a radio dispatch company, elected to serve primarily the airport, hotel taxi stands, and public cab stands only - foregoing dispatch calls, voucher business, and other traditional taxi markets.

The airport market became the primary market for these independents; soon even the largest airport taxi holding lots were insufficient to accommodate the large numbers of taxi drives who preferred to exclusively work the airport. Often lots of taxi drivers would be seen queuing up at airport taxi holding lots – often in the blazing sun and bitter winter weather to wait several hours for an airport fare. Not wanting to appear unsympathetic to the plight of these drivers – now mostly immigrant drivers – airports commissioned the construction of physical facilities and creature comforts on these lots which provided airport drivers with restroom facilities, heated and air conditioned indoor waiting areas, TV, and even game rooms to assist them with their long waits. These facilities became the primary gathering place for taxicab drivers

in the area – especially new drivers who were unsure of the area's geography. Airport passengers were typically only going to a few downtown places, or if a local resident, could tell the driver how to get there.

With no central company controlling the age, cleanliness, and general actions of these drivers, it befell the airport administration to become the personnel department for these drivers. Soon North American airport officials were permitting taxi drivers for their facility alone, providing mandatory age and inspection of vehicles, supervising their operations and behavior on airport property, handing complaints from customers, and finally, disciplining the drivers even to the extent of refusing them access to the airport when offenses became too frequent or severe mistreatment of the airline customer occurred.

Often, when conducting customer surveys on airport services, taxicab service would be ranked as being poor to unusually poor due to the age, cleanliness of vehicles, driver appearance (and fragrance), and fares. Airports were receiving numerous complaints from customers about being "ripped off" by taxi drivers taking the long way, charging illegally for large bags or more than one bag. Some drivers went so far as to insist that their religious beliefs forbade them to transport any passenger that had a dog or appeared to have liquor on their person.

In response, North American airports have evolved several taxi dispatch models, ranging from continuing open entry to their airport to single concession agreements, with all taxi matters being handled by the successful

bidder to provide the services under contractual agreement to the airport. Each of these alternative types of airport taxi dispatch is discussed more fully below.

7.1 Alternative Airport Taxi Dispatch Models

Airports in the US dispatch on-demand taxis in a variety of ways under vastly different conditions and models. Many larger airports, such as the Miami Dade County International Airport, Washington Reagan National Airport, D/FW International Airport, Atlanta Hartsfield International Airport, Chicago O'Hare International Airport, Minneapolis-St. Paul International Airport, Denver International Airport, and San Francisco International Airport are more or less "open" airports. That is, any taxicab and driver permitted to drive in the primary city or, in some cases, any of a number of surrounding cities, can purchase an airport tag or license and get into the airport holding lot to wait for a trip from the airport.

A smaller number of other airports such as the Washington Dulles International Airport, Tampa International Airport, and Orange County's John Wayne International Airport, are partially closed and limit the number of taxi companies to two or three by competitive bid concession agreements.

Finally, there are a number of airports, typically smaller airports that primarily utilize a single taxi concessionaire, or limit the total number of taxis to provide

their walkup or on-demand taxi services. Airports such as Fort Myer's Southwest Florida International Airport, Raleigh-Durham International Airport, Sacramento International Airport, and Sea-Tac International Airport have either a competitively bid single concessionaire on-demand taxi provider or a single association of independent taxi drivers that attempts to balance the demand for taxis with the correct supply. There are, of course, hybrid models such as that at San Jose International Airport that attempts to permit a portion of taxis from every taxi company authorized in the City to serve the airport. Each of these airport taxi dispatch models is discussed more thoroughly below.

7.1.1 Open Airport

Perhaps the worst approach to dispatching airport on-demand taxicabs can be found in the open airport approach. When a city or group of large and small cities surrounding a large international airport has permitted an excess of taxicabs to be licensed or permitted within their jurisdictions, there are usually a correspondingly large number of excess taxis and drivers at the airport. Typically, this pool of airport-only drivers – meaning they serve mainly deplaning passengers to the city and then deadhead back to the airport to get another fare – form a large group of vocal taxi drivers who demand better conditions for themselves at the airport during their wait of two or three hours or more.

These conditions often involve shelter that can mean new facilities, in-facility food services, restrooms, and even prayer rooms to support some drivers' daily worship. These drivers often are quite vocal and demand a minimum fare from the airport -- as much as $15 or $20 dollars although the passenger desires to travel just a few miles off the airport. Their rationale is that since they (voluntarily) have to wait two or three hours for a fare, they should not be expected to accept a $5 or $7 fare. At airport after airport, these taxis are typically the oldest in the area, require daily inspection, significant airport oversight with respect to charging the correct fares, accepting all passengers, attempting to achieve forgotten articles left in the airport taxi, and processing of complaints.

Airports which permit all taxi licensees in their primary city or surrounding cities as well, are the conditions found at Miami, Dallas, Denver or Minneapolis – St. Paul airports. In Miami and Dallas for example, which have open entry taxi systems, the number of taxis waiting for entry to the pickup curb can be four to five hundred taxis a time with waits of two, three, or more hours for a fare.

(Insert Image: Figure 7.1)

Figure 7.1 Miami International Airport Taxi Holding Lot

In addition to the greatly increased size of the holding lot required to park this large number of vehicles, other airports have been forced to provide physical facilities for the drivers of these vehicles while they wait for their turn to go to

the airport curb. The "average" wait time for large open airports contacted were between two and one half hours with many approaching an average three hours wait due to declining airline traffic.

As shown, the physical facilities constructed by other airports to house their waiting drivers, such as in Miami and Dallas are considerable and expensive to maintain. There is an attempt to recapture these costs through airport dispatch fees, but in airports such as Miami International and DFW, costs exceed revenues by a million dollars or more per year. In addition, these airports have relatively higher taxi gate fees which are passed along to the passenger at the time they enter the airport taxi. Miami has a $2.00 trip fee for both picking up and dropping off at the airport. DFW receives $2.50 per taxi dispatched plus a small 10 cent surcharge for the Automatic Vehicle Identifier (AVI) system utilized by the airport.

(Insert Image: Figure 7.2)

Figure 7.2 DFW Taxi drivers waiting area

With respect to airport gate fees it is important to point out when comparing airports that it is not the absolute amount charged that is important but the margin left after all costs are taken out of the fee. In the case of Dallas and Miami, their fees do not begin to cover their airport direct costs since these airports self manage their taxi operations. Seattle International Airport, on the

other hand, receives most of their fee with little cost attached since their base taxi operator, STITA, manages a major portion of the operation.

The number of customer complaints received by the airports regarding their taxi service is directly tied to their local conditions and the way they arrange for taxis to be dispatched at their curbs. If there is a single concessionaire that receives and handles all taxi user complaints, then there are typically few, if any, user complaints processed by the airport. If however, the airport staff is directly responsible for managing the holding lot and the curb pickups, in an open airport environment such as in Minneapolis, the complaints are numerous. MSP receives an average of 50 complaints per month which the staff must then process and respond to. Most larger airports report having far fewer complaints, but still a substantial number in comparison to other services offered at the airport. Even in a well managed airport taxi operation such as that at DFW, the complaints will average one per day. Complaints by taxi drivers about the personnel and processes DFW utilizes are now handled by a third party arbitrator, paid for by DFW.

A common complaint mentioned by airports officials is the cost of maintaining the large taxi holding lots and related facilities. Restroom facilities were constantly mentioned as a large cost due to the heavy use of several hundred drivers daily.

Given the large number of drivers in most airport taxi holding hours, waiting long hours for another fare, there are typically a number of clashes which may

require police to enter the lot to settle disputes. Most airport managers commented that this occurs infrequently at their airports – perhaps once or twice per year, but that airport police are instructed to continually monitor the holding areas as part of their regular rounds.

Ironically, in one airport taxi study after another, it has been determined that this open entry behavior creates another inefficiency found in community taxicab operations in the actions of cab drivers who do not primarily serve the airport except for prearranged pickups. These cab drivers will not usually undergo the long wait times associated with the airport holding lot. They bring passengers to the airport and then leave – deadheading back to town, seeking other radio calls or business elsewhere rather than wait two or three hours for a fare. It is ironic that these taxi drivers earn the greatest amount of revenue for the time they spend driving a taxi. They typically serve more people per day. Unfortunately, this system of one taxi fleet coming to the airport and leaving empty and another leaving with a fare but returning empty is an extremely energy inefficient and wasteful airport taxi system.

Given the number of complaints and the manpower required to manage a large number of taxi drivers in an open system, California airports such as San Francisco International and San Jose have commissioned a third party to manage their taxi holding area(s) and curb dispatch. The additional cost of a third party to manage the on-demand taxis and the desire for a minimum fare often drives the cost of airport taxis up substantially. In recent years,

competitive bids for airport curb dispatching companies for larger airports were in excess of $4 or $5 dollars per dispatched taxi if a number of terminals were involved.

Some airport officials and community taxi leaders defend the open airport as the only way the airport can have the total number of taxicabs required at peak times or during peak seasons. Still, a common complaint among the open entry taxi airports is the lack of taxis during evenings, weekends, or periods when there is heavy demand elsewhere. It is for this and other reasons of poor service that almost all the open entry airports named have at one time or another sought to improve the image of their airport taxis and ensure quality services – all the while lowering their administrative costs by moving to some form of limited or single taxi on-demand concessionaire.

However, the political costs of closing an airport to all taxis are steep, given very vocal and entrenched taxi drivers. These drivers or their representatives offer the public the sentiment that they have served the airport faithfully and now the airport is attempting to prevent them from making a living. As a result, most airport officials have not conceded to taking actions which would make the airport seem as though they were not sympathetic to the driver's plight.

In all fairness, it should be noted that some large airports such as McCarran International Airport in Las Vegas, Nevada operate very well with an open taxi system. However, McCarran is a special example where the total number

of taxis is capped in the City and the demand for taxis is unusually high – reaching 8,500 on peak days. Also, Las Vegas taxis companies are the last major city taxi companies to utilize employees rather than independent contractor drivers. These drivers work ten hour shifts, are paid a salary, and are guaranteed a base level of income irrespective of the number of trips they may offer during their shift.

Finally, McCarran Airport is relatively simple airport to serve by taxi. There is one moderately sized taxi holding area leading to a single curb for pickup. Taxis move rapidly through the lot to the curb given the high demand and rarely spend much time in the holding lot.

7.1.2 Limited Entry

Limited entry of on-demand taxi services has the twin advantages of allowing more than one taxi company and its drivers to serve the airport and at the same time, gaining some degree of control over the supply of taxis to the airport when they are needed. It also can substantially lower the costs of administering the taxi dispatch and curb management function when these tasks can be turned over to the taxi companies themselves, as in the Tampa International Airport.

Having two sides to their airport, Tampa officials decided some time ago to have a single on-demand taxi company for each side of the airport, allowing

them to manage the number of taxis, their holding lot, and curb pickups. The service is competitively bid by taxi companies licensed to serve Hillsborough County, which encompasses the airport. Each successful taxi company decides how many and when to allocate taxis to the airport but are penalized if they do not adequately serve the demand for walk-up taxi service.

John Wayne Airport, near Los Angeles, California, has a similar approach, with concessions for only two taxi companies from Orange County to serve their airport. These two concessionaires take turns in supplying taxis – that is, every other one dispatched is from one or the other taxi company. Just as in the case of Tampa's International Airport, John Wayne Airport is able to set high standards, receive a concession fee for service, and has few to no day-to-day management of the holding lot or taxi curb.

Finally, there is the example of Dulles International Airport that, until this year, had a single airport taxi concessionaire approach to their on-demand taxi operations. One company competitively bid and provided the 600 daily taxis needed to meet the Dulles taxi demand. Due to considerations that a single taxi company could no longer supply the large number of taxis required and the desire to spread the concession to more than just one taxi company, Dulles officials competitively bid three taxi concessions – each with 200 taxis to serve the airport. They also bid a fourth concession of a taxi dispatch company to manage the curb and the three successful taxi companies. It is hoped that competition among the three taxi companies will result in a higher level of taxi service to the traveling public. Unfortunately the extra cost of

paying for the taxi curb dispatch company will come from the three taxi companies and driver fees, adding to the cost of taxi service from Dulles.

A variation of this is utilized by Sea-Tac officials in managing their airport demand. A single association of taxi drivers, SEATA, has provided primary service to the airport. This limited number of taxis, 166, is the base fleet responsible for the nearly 2000 daily dispatched taxi trips from Sea-Tac. However, four other taxi companies have rights to be called whenever SEATA cabs are in danger of forcing a customer to wait more than five (5) minutes. These companies are called in rotation to fill in when needed. For Sea-Tac the system appears to have worked successfully. However, it should be noted that in Seattle, the taxi system has been noted for having an excess of taxis available. This may not be the case in other communities.

7.1.3 Single Taxi Concessionaire

The single taxi concessionaire approach has been very successful for smaller airports such Raleigh-Durham Airport and Southwest Florida International Airport and as noted above, for Sea-Tac. In these smaller airports however, there were a number of small one, two, or four-car taxi companies that served the open airport. Airport personnel managed the holding lot and curb dispatching. Taxis were old; service was tired and sometimes refused if the trip length was short.

Through a competitive bid for a single taxi concession, these airports were able to specify vehicles to be no older than four years, drivers to be in uniform, and for the company to manage the curb. In the case of RDU, airport taxi service went from an embarrassment to world class taxi service overnight, with the new single taxi concession taxi agreement. The airport's costs were decreased by more than $500,000 annually and they began to receive significant positive revenues from the taxi concession after the first two years of operation.

Southwest Florida International Airport achieved similar results with a dedicated single taxi service – newer cars, personal service, uniformed curb dispatchers, integrated wheelchair accessible taxi service, complaint free, and positive concession revenues from what had been an expensive-to-manage, continual hassle with a collection of independent small taxi drivers and companies. Arriving passengers are now greeted with a uniformed taxi attendant, assisted with their luggage, provided a cold bottle of water and daily newspaper for their taxi trip. The service is provided in a uniformly white sedan and wheelchair accessible vans for rates slightly above $2.00 per mile and a small fuel surcharge.

Even larger airports can benefit from a single taxi concession for on-demand service. As mentioned, airports such as Sea-Tac International Airport and Sacramento International Airport have single concessionaire taxi systems, but they have gone about it in different ways. In Seattle's case, they placed a moratorium on the number of taxis that could serve the airport, with no

replacements, and kept it there for more than five years, letting supply shrink to meet available demand.

Today, there is a better balance with supply and demand and the remaining fleet has formed an association (STITA) to self-manage their single concessionaire taxi service. Through their exclusive agreement with STITA, Sea Tac has been able to request and receive a greening of their base taxicab fleet. All vehicles are CNG vehicles.

While there is a constant problem with taxis within the community of Seattle, the airport taxi service is regarded as being much better. While the current system evolved over a period of time with STITA being the only association of taxi providesr, airport officials plan to create a true concession taxi system and competitively bid it when the current agreement expires in 2010.

California's capital city airport, Sacramento International Airport, being overwhelmed by their open airport taxi system which required constant management, dispute resolution, and constantly embarrassing service, closed their airport to only a prescribed limited number of taxis. Each taxi company represented at the airport was permitted to have a small percentage of the total number of taxis required. This percentage was determined based on the size of their current total fleet. Airport costs of administration were significantly reduced from a high of $5.00 per taxi dispatched to a much more manageable $2.00 as a result of the closing of the open taxi system. Officials at

Sacramento International Airport indicate they are very pleased with the resulting service.

In almost all of these single concession taxi dispatch airports cited, there is either a good balance of taxis coming to the airport and those picking up at the airport or there were not significant taxi demand peaks which made it impossible to serve the demand with a single taxi system. Also in most, if not all the cases, the single concession airport taxi has authority to pick up passengers and to bring them back to the airport, thereby creating a more efficient taxi network with fewer deadhead miles. Finally, there were typically one or two major corridors or city centers being served by these taxis, permitting them the opportunity to pick up or for their management to arrange return trips to the airport.

One of the most unique and successful North American airport taxi dispatch operations has been that at Los Angeles International Airport, which permits all 2,000 taxis registered among nine separate franchised taxi companies in LA to serve the airport. However, they are permitted to do so only on a limited number of days, thereby reducing the total number of taxis able to serve the airport at any one time but still giving all taxi drivers an equal opportunity to serve the lucrative airport taxicab market. This system is explained in much more detail below.

7.1.4 LAX Taxi Dispatch and Curb Procedures

The taxi dispatch operation at LAX starts with taxicabs entering the airport holding lot and paying $2.50 to the taxi dispatch operator. This gate fee is currently paid in cash but will be collected electronically by the airport in the near future. Of this $2.50, 50 cents is paid to the airport and $2.00 is paid to the taxi dispatch operator, ATS.

Once the gate fee is paid, the taxi driver proceeds to the "bowling alley" parking lanes where they line up to be signaled to the holding lot dispatch booth window.

(Insert Image: Figure 7.3)

Figure 7.3 United Independent Taxi

At the booth window, they are given an airport taxi dispatch form that is computer printed with the information as to which of the nine terminal curbs they are being dispatched.

(Insert Image Figure 7.4)

Figure 7.4 Taxis in a row

(Insert Image: Figure 7.5)

Figure 7.5 Yellow Cab Company

Uniformed taxi curb personnel at each of the nine terminals use portable phones to call the taxi dispatch booth to request one or more taxis. These requests are input in the computer to print a specific form for each dispatched taxi. The time for taxis to enter the lot, wait in line, and then receive their curb information form typically takes less than twenty minutes, but can take slightly longer during slow periods.

Once a taxi driver has his dispatch form, he proceeds to the indicated curb and hands this form to the curb personnel. The curbside taxi personnel will typically take this form and place it under the wiper blade on the passenger side of the taxi. When passengers approach, they are greeted by the curb personnel, helped with their baggage by both the curb attendant and the driver, and handed the taxi terminal dispatch form shown below. Due to the volume of taxicab traffic at LAX, commercial taxis are given the inside curb lane and have specifically marked spots on the curb near the airport exit doors.

(Insert Image: Figure 7.6)

Figure 7.6 Trip Record

After the cab is loaded with passengers, the taxi driver departs the airport for the passenger's destination. Once the passenger(s) are delivered to their destination, the driver returns immediately to the airport taxi holding lot to pay another airport taxi gate fee and to repeat the process again.

(Insert Image: Figure 7.7)

Figure 7.7 United Taxi

ATS staffs each of these taxi curb pickup areas with either one or two taxi curb personnel, depending upon volume. As previously mentioned, the taxi driver must give the curb dispatcher the computer generated terminal dispatch form as verification that he/she has paid their airport gate fee and that they have been dispatched from the booth to that specific curb. These taxi curb personnel also greet the customers and help them with their bags, getting in the taxi, and giving them the taxi dispatch form, which contains information on that specific cab and company information which can later be used in the case of any lost articles.

During early morning hours when traffic is slow, individuals who require a taxi when there is none on the stand can use a conveniently located taxi telephone to call the taxi holding lot booth, which is open 24/7.

(Insert Image: Figure 7.8)

Figure 7.8 Taxi Stand at airport

LAX has traditionally limited LA taxicabs to enter the on-demand taxi holding area only one of every five days. The other four days these taxicabs have had to serve a specific franchised area of Los Angeles. As previously mentioned,

the City of LA has a unique taxi regulatory structure which permits nine (9) franchised taxi companies to operate on-demand within the City and LAX. Each franchise taxi company has a specific geographic area they serve, but they all participate in the LAX walkup taxi business.

The taxi dispatch at LAX is currently experimenting with twelve-(12) hour shifts instead of one day (of every 5), and taxis are permitted to participate in the on-demand holding area once every two and a half days for a twelve-hour period. This was done out of concern that some taxi drivers were driving too many hours without rest. The new system, however, still strictly limits the number of taxis, so the wait time is relatively short.

LAX currently dispatches between 5,000 and 6,000 taxi trips per day, but has a taxi holding lot of fewer than 100 spaces with a staff of 82 personnel. This lot is maintained and cleaned by the airport taxi dispatch operator. Most of the time this lot will have between 20 and 40 taxis waiting to be dispatched by the booth window.

(Insert Image: Figure 7.9)

Figure 7.9 Taxis waiting at Underpass

(Insert Image: Figure 7.10)

Figure 7.10 Outside Tables

This lot is clean and free of any trash or other debris. Highway bridges shade a portion of this lot. There is a seating area for drivers next to the canteen-style food service off to one side of the taxi holding lot. There are air-conditioned restroom facilities for drivers, kept sparkling clean and also maintained by ATS.

(Insert Image: Figure 7.11)

Figure 7.11 Catering truck provided for taxi drivers' use

(Insert Image: Figure 7.12)

Figure 7.12 Washroom facilities provided for taxi drivers' use

The taxi dispatch operator additionally maintains a dynamometer and taxis are selected at random for inspection as to the accuracy of their meter. Taxis which fail are immediately removed from airport service and reported to their owner. The taxi dispatch operator also maintains a free car wash for all taxis. Taxis which are not clean can be ordered to use the free car wash before being dispatched to the airport curb. The airport dispatcher also enforces the airport's dress code of white shirts and dark pants/skirt on all drivers and they may issue fines and penalties for drivers not following airport rules. A third party is employed to hear any appeals of these fines and penalties. Complaints

about LAX taxi services are few – typically 12-15 complaints per year. Seldom are police called to the airport taxi holding lot, perhaps once or twice per year.

Driver Representative Issues

As a recent study of the LAX on-demand taxi starter review process, Los Angeles taxi representative spokespersons for the drivers were interviewed with respect as to how drivers perceived the airport holding lot and dispatch procedures. There was concern by some drivers that appeals of airport taxi and holding lot violations consumed far too much time and were often arbitrary. There were also concerns about the health and welfare of drivers. While they felt this airport taxi dispatching process permitted the drivers the best opportunity to maximize their incomes under the current system of franchise management of Los Angeles taxis, there were issues they wanted addressed.

Their concern was that LAX taxi drivers did not have more shade at the holding lot – that there was not the ability to buy healthy foods such as fruits and vegetables from the current food vendor at the lot, and that the resting area could better serve the drivers by having some workout machines available for their use. They explained that drivers work continuously during their day or shift at the airport, and although their time in the lot is relatively short when compared to other airports, the drivers needed to eat better and get some exercise. Thus, requiring more salads and vegetables from the food truck

currently serving the lot would assist drivers in having the opportunity of a more healthy diet. Also, simple exercise equipment they felt would allow drivers to make the best of what time they do have between airport pickups.

Conclusions

Airport taxis are common throughout the world and most airports seek to regulate them in some fashion in order to guarantee that their services will be available but also to insure visitors and tourists to the area that the service will be of good quality and that drivers will treat their passengers well. Airline passengers, new to the area, can not use trial and error to select a good taxi company but rather must rely on airport officials to arrange these services for them.

Airport landside managers in the U.S. and Canada are very aware of the need to manage the quality of their taxi services. More and more attention is being given today to the concept of a closed or restricted entry airport taxi system whereby taxicabs are either turned over to a single company to operate with very high standards or managed as a single entity, matching daily demand for taxis with supply.

The movement to concession airport taxi systems or metered taxi system is being driven by a number of factors. There is obviously a need to eliminate extremely long wait times by taxi drivers at the airport and the problems associated with two sets of taxi operations – one to take passengers away from

the airport and another to bring them to the airport. Such airport taxi systems are inherently energy inefficient and expensive to operate – driving the cost of taxi service higher than it really needs to be. The second is the cost to manage the open airport taxi system. If all taxis are permitted to arrive at the airport at any time, the airport becomes the region's largest taxi stand, requiring parking facilities and driver amenities. The land, physical facilities, driver and vehicle permitting, curbside management, and user complaints are time-consuming and expensive for the airport. Therefore, it is expected that these trends toward closed or managed airport taxi systems will continue in the United States and Canada.

Chapter Eight: The role of the taxi in specialist transport services

Introduction

An additional role for the taxi has developed in relation to social and specialist transport. The term Specialist Transport Services (STS) has been applied in a variety of contexts. The field for and design of such services tends to differ much more significantly than that associated with mainstream taxi transport, and is reflected for example by a wide array of differing legislation appropriate to vehicle type, carriage of wheelchairs, and 'social' transport provided as a back up to individuals without access to cars. Differing laws, including the Disability Discrimination Act (DDA) in the UK, and the Americans with Disabilities Act (ADA) have contributed to the development of these uses, but have not provided for a harmonious service concept or method of delivery.

This chapter investigates the specialist uses of taxis, and includes analysis of their role in the carriage of individuals with ambulant disabilities, and those with specific specialist needs. It develops the definition of Specialist Transport Services to embrace a variety of activities beyond that of medical-related special needs.

8.1 What do we mean by Specialist Transport Services?

As noted in the introduction the term Specialist Transport Services (STS) has been applied in a variety of contexts. Most commonly it has been applied in the context of special needs, often medical-related, and frequently referring to the transport requirements of elderly and disabled. A typical (also large-scale) example is the Flexlinjen shared taxi system in Gothenburg which is described below (see Westerlund et al, 2000). Specilaist services also apply to the wider use of the transport in social development, for example where a taxi is used to support a journey to work that would not otherwise be made; and by extension should also be considered as contributing to the economic life of the individual and of the communities it serves.

One of the most widespread characterizations of STS has been as Dial-A-Ride – a simple solution of providing on demand transport via a telephone booking service, though this has been developed recently to include internet booking. Dial-a-ride is frequently classified as part of the wider family of Demand Responsive Transport (DRT) Services, those sevices responding to differing dtimulae and demands, which emerged as a significant form of transportation from the late 1960s onwards. Mageean and Nelson (2003) note that the original objectives of Dial-A-Ride were to cater for widely dispersed trip-patterns and to provide a service in low-density (often suburban) areas for mainly non-work journeys, and required pre-booking over extended time periods. Intending users would telephone in their requests some days before they intended to travel and the operator would plan the service the day before

the trip. Very few of these initial schemes met with widespread success and traditional Dial-A-Ride services have often been criticized because of their relatively high cost of provision, their lack of flexibility in route planning and their inability to manage high demand. Some schemes did develop moderate customer bases and considerable international experience in special needs transport was gained (see for example, Ashford and Bell, 1978). Many of the earlier limitations have subsequently been overcome through the introduction of transport telematics - essentially the application of new technologies, a summary of which s set out in Mageean and Nelson (2003), and the development of a much broader definition of Flexible Transport Services (FTS), discussed in Section 8.3 below. In the USA the term ADA-complementary paratransit is coined to describe some forms of STS (Lave and Mathias, 2000), mainly those aimed at carrying individuas with ambulant disability.

A typical Dial-A-Ride service will provide a specifically marketed door-to-door transport service (eg: LinkUp, in Tyne and Wear, UK; or the DOE door-to-door services in Northern Ireland) for local residents who cannot use the conventional public transport system, due to a mobility or sensory impairment. Members of the Tyne and Wear service can book a vehicle 24 hours in advance to travel anywhere via fully flexible routes. The service can be used for employment, education, shopping, hospital appointments, leisure or just visiting friends and relatives.

Telematics-based DRT systems are based upon organization via Travel Dispatch Centres (TDCs) using booking and reservation systems which have the capacity to dynamically assign passengers to vehicles and optimize the routes (see Figure 8.1). Automated Vehicle Location (AVL) systems are used to provide real-time information on the status and location of the fleet for the route optimizing software. These systems mirror closely the developments in taxi technologies and software described in Chapter five and it is not uncommon for one software supplier to have products for both the taxi and DRT markets.

(Insert Image: Figure 8.1)

Figure 8.1: Schematic Representation of Telematics-based DRT (source: Brake et al, 2006)

A recurring challenge to the operation of Dial-A-Ride services and other forms of STS has been the provision of appropriate vehicles. Westerlund and Stahl (2004) note that ideally STS service providers should be able to keep a fleet of different types of vehicles ranging from passenger cars to special lift-equipped vans and minibuses. Furthermore, as these vehicles will be used in integrated transport systems they should be flexible in both design and use. Westerlund and Stahl describe two projects completed in Sweden, one to develop a small Multibus, the other to develop an accessible maxi-taxi vehicle known as the Taxi for All. Further issues relating to vehicle design are referred to in Section 8.4.

In a European context the experience of Sweden in providing STS is significant. In addition to innovative developments in vehicle design (Figure 8.2) there is also considerable relevant experience in the operation of STS. Gothenburg is the second largest city in Sweden with a population of about 500,000. In 1992 the city invested in PLANET, an advanced DRT system for Special Transport Services (STS), and a fleet of shared-ride taxis and specially equipped vans. PLANET handles the booking, planning and dispatching of over 200,000 demand-responsive trips per year using 25 fully accessible minibuses, mostly by elderly and disabled persons who are unable to use regular public transport. As can be expected such service requires a high degree of municipal subsidy. The CONNECT Consortium (2005) note that in Sweden, and subsequently the other Nordic countries, Special Transport Services (STS) emerged using special vehicles to handle wheelchairs but also with a practice of contracting regular taxis locally. All municipalities were required by law to provide such services to everybody who could not use mainstream public transport. The importance of further DRT development can be stated by the fact that it handles about one percent of all public transport trips in Stockholm County, but requires 10-20% of all tax funding for public transport. These figures are quite comparable to those in many US metropolitan areas, following the strict accessibility regulation in the Americans with Disabilities Act (ADA) 1990 (see Chia, 2008).

As part of a demonstration in the EC-funded SAMPLUS project services were evaluated in Högsbo, an urban district of Gothenburg (Mageean and Nelson, 2003). The objective of the demonstration was to provide an efficient telematics-based door-to-door STS for the elderly population, and to reduce the cost of provision with a minimum of service reduction, whilst also increasing mobility (at a reasonable cost) for elderly people who are not eligible for STS but still have difficulty using regular public transport.

The solution applied in Gothenburg comprised two fixed end-points with scheduled departures (every 30 or 60 minutes in each direction), a fully flexible corridor service between end-points according to requests for pick-up and drop-off, door-to-door service for STS persons eligible for STS and predefined stop points to assure a walking distance of less than 150 metres for other elderly persons. Services are provided by the city authority's special transport services division.

In North America, the term paratranist is used to embrace ADA-complementary paratransit and all other forms of DRT (Lave and Mathias, 2000). Other US literature has defined DRT as 'specialised transportation for older persons, persons with disabilities … also provided to the general public, particularly in areas with lower population densities or lower levels of demand' (Schofer et al., 2003). The early history of "paratransit" is well described by Kirby et al (1975). As in Europe, there is approaching 40 years experience with dial-ride, shared taxis, ride-sharing, fixed route and route-diversion jitneys, shuttles, etc. Aldaihani et al (2004) note that with the

passage of the American with Disabilities Act (ADA) the growth in demand for DRT systems has been tremendous. The first ADA complementary paratransit services began in 1992 and by 2004 paratransit ridership increased by 58.3%, to more than 114 million trips, most of which were ADA-complementary (Chia, 2008). Since the ADA sets strict guidelines for service providers with respect to trip refusals and on-time performance, service providers are expected to offer better services whilst experiencing increased usage. Chia (2008) emphasises that the increase in paratransit trips and the substantial difference in service trip costs when compared with the cost for other modes are prompting transit agencies to seek more effective and efficient ways to meet the growing demand for ADA complementary paratransit services.

The CONNECT Consortium (2005) contrast the Nordic and North American experience with STS noting that the big difference is that the tax funding for both mainstream and flexible public transport is proportionally much less in the automobile-oriented USA. Nevertheless, 20 of the 30 largest DRT service providers are North American. Few of these operations provide open DRT services that are beyond the ADA regulations. Pittsburgh is a notable exception where the Pennsylvania State Lottery is a good source of funding for elderly care services including senior mobility. Other interesting examples of open DRT include shared-taxi services in Wisconsin and examples of Taxibuses in Rimouski, Canada.

Where an authority provides a Dial-A-Ride service it is normally the case that this service will not provide transport to hospitals or social service day centres where transport is already provided by either the local council or the health authority (e.g. via non-emergency patient transport services). Consequently, it is important that these other forms of transport are integrated into the wider STS offer. Interaction with other STS providers does inevitably introduce additional complexity for authorities, operators and passengers alike. For example, in a typical British region one can identify (at least) five major categories of overlapping service provider encompassing: the Strategic Health Authority (SHA); the Ambulance Service; the commercial and tendered bus network; the taxis and PHV network; and the local authority, education and social services transport – all of whom may contribute to the provision of STS. These are issues which may in part by addressed by the "Agency" approach to the provision of multiple transport services (see Section 8.3).

More recently there has been a move to integrate STS with other forms of DRT in a joint operation. For example, Nexus (the Tyne and Wear Passenger Transport Executive) now combines operating contracts for their Care Service and DRT services dispatched via a common dispatch centre and branded as LinkUp. This service is supplemented by TaxiLink which provides a door-to-door service using accessible taxis for users with greater mobility difficulties.

Similar but more extensive developments have occurred in the Netherlands. This followed a Government initiative to promote a combination of mobility services for users with special needs and "open" DRT services (for

everybody), filling the gap in services between mainstream public transport and conventional exclusive ride taxi services. RegioTaxi, a combination of a community transport, STS and open shared-ride taxi service for non-eligible users has become very popular and since start-up in 2000, RegioTaxi KAN in the Arnhem-Nijmegen region has grown to almost 1.4 million passengers per year. About half of the users are eligible for a higher subsidy and half are the general public paying a larger portion of the transport cost. Their fare is still about half of that for a corresponding exclusive taxi ride. Similar developments can be seen in Denmark, although on a much smaller scale.

8.3 The development of Flexible Transport Services

Brake et al (2006) note that Flexible Transport (FTS) is an emerging term which covers services provided for passengers (and freight) that are flexible in terms of route, vehicle allocation, vehicle operator, type of payment and passenger category. The flexibility of each element can vary along a continuum of demand responsiveness (see Figure 8.2) from services where all variables are fixed a considerable time before operation (e.g. a conventional public transport bus route) to services whose constituent variables are determined close to the time of operation. Taxi services typify the demand responsiveness of public transport.

(Insert Image: Figure 8.2)

Figure 8.2: The Demand Responsiveness of Public Transport (source: Brake et al, 2006)

The true potential of FTS as a contributor to sustainable mobility is not yet been fully exploited – partly because the necessary supporting frameworks required to deliver more effective and competitive transport solutions are not yet fully understood. The potential for FTS has important implications from the viewpoint of transport logistics and the environment since there are considerable opportunities to reduce road traffic, to save operating costs and to increase the level of service experienced by passengers.

(Insert Image: Figure 8.3)

Figure 8.3: The Demand Responsiveness of Different Modal Options (source: Brake et al, 2006)

Demand responsiveness can also vary within and between modes in terms of the type of service that is offered. Drawing on British examples Figure 8.6 illustrates these variations based on the operation of distinctly recognisable standalone services – the way in which transport is generally viewed at present. The overall level of responsiveness for all modes can be increased by brokering vehicles and operators.

8.3.1 Multiple service provision and the Agency approach to flexible transport services

The provision of multiple service provision is crucially dependent on the employment of appropriate telematics since this enables the required level of management information with the possibility of a real-time dimension.

The Standalone layer chiefly differs from the Basic layer in the level of telematics offered, i.e. services are scheduled and dispatched by software, thereby enabling on-day booking. Software is likely to include reporting functions to assist with planning and financial arrangements and thus can deal with higher demand levels on individual services and more services in total. The traditional Dial-A-Ride services discussed in Section 8.2 are indicative of the basic layer.

The Expanded and Mature Agency layer moves into the management of multiple service providers, such as a combination of supported services, voluntary services, taxis, statutory special transport services and voluntary car schemes. These may be managed as a set of independent services, economies of scale deriving from the use of a single TDC or there may be some integration of services, such as the transportation of the general public and education contract passengers on the same service journey. At this level the use of vehicular resources from different modes can be integrated, but requires information on the availability of vehicle types and their periods of vehicle availability, periods of driver availability, operators' prices for providing the

transport services and institutional/regulatory conditions of each mode that may affect the management and scheduling functions.

Figure 8.4 illustrates an example of a Mature Agency and demonstrates the role that taxi services can play when integrated within the flexible transport offer.

(Insert Image: Figure 8.4)

Figure 8.4: A Mature Agency: DARTS, Angus, Scotland (Brake et al, 2006)

Although a variety of organizational and institutional factors have prevented the further development of the Nexus TDC it remains the case that full integration of these services would allow a combination of trip patterns, e.g. combining general public transport carriage with Community Transport, Social Services and PTS on the same journey. A more likely first step would be the provision of general public transport trips when non-registered (STS and other) journeys are not required.

At the final layer of Interacting Agencies, which is yet to be achieved, many resources are integrated, including the pooling and optimization of investment capital, vehicles and human resources. It is unlikely that the Agencies can operate without telematics-based scheduling and dispatching functions and telematics-based revenue management systems are probably essential. The highest level of interaction between Agencies involves the use of software that

freely enables both geographical and organizational cross-border management, either through a single regional TDC or through a set of TDCs.

8.4 Legislation for Specialist Transport Services, the UK experience

At a European level Kalliomaki et al (2004) have considered the principal organisational, institutional and juridical issues that are emerging as greater understanding is gained of telematics-based flexible transport services. They note that the concept cannot be developed and run if the legal framework prevents it. In most countries there is no legislation for DRT. Emerging legislation will determine the DRT concept, obligations and possibilities. The juridical framework and regulations should not only cover technical issues, but also issues related to subsidies, responsibilities, existing regulations etc.

8.4.1 Specifications for service type

The definition of a taxi license, by taxi type, is detailed in chapter two. In the UK, these are supplemented, in the instance of specialist transport service, by more traditional bus licenses, and include:

A Public Service Vehicle (PSV) Operator's License, also referred to as a Passenger Carrying Vehicle (PCV), which enables passengers to be carried for hire or reward. Generally the vehicle will have more than 8 seats, but less than 8 can be used for private hire work (if it is a small part of the business).

A Hackney Carriage License for up to 8 seats allows the operator to pick up a passenger from a taxi rank or the street.

A Private Hire Vehicle (PHV) Operator's License for up to 8 seats specifies that passengers must be pre-booked and not be picked up from a taxi rank.

A Taxibus License, specific to some authorities only, allows for taxi vehicles to be used to pick up journeys in multiple occupancy with varying start and end points for each passenger.

Holders of these licences can then operate services according to legislation which specifies the number of seats that can be used on each service type.

Service Type	Section	Vehicle Restrictions
Flexible Local Bus Service provided by an operator with a standard PSV operator's licence	Section 21 Transport Act 1985	More than 8 seats
Flexible Local Bus Service provided by an operator with a restricted operator's licence	Section 13 Public Passenger Vehicles Act 1981	Operator can only have 2 small vehicles, each less than 8 seats Exceptions enable up to 16 passengers: vehicles not part of a passenger transport business, e.g. hotel; main job is not PSV operation

Taxibuses	Section 12 Transport Act 1985 (excludes NI)	Up to 8 seats
Flexible Local Bus Service for general public provided by a non-profit making body	Section 22 Transport Act 1985	Minibus 9-16 seats
Community bus service run by a non-profit making body where no members of general public are to be carried	Section 19 Transport Act 1985	Small bus permit for 9-16 seats Large bus permit for >16 seats
Excursions and tours	Section 137 Transport Act 1985	-
Shared taxi and private hire vehicles (PHVs) - advance bookings	Section 11 Transport Act 1985	Up to 8 seats
Shared taxis – immediate hirings	Section 10 Transport Act 1985	Up to 8 seats

Table 8.1: Vehicle size constraints for service types in Great Britain[19]

8.4.2 Registering an STS

In a UK context the juridical status of STS has been unclear, with applications being hampered by issues of how to register services successfully (Brake et al, 2007). This is illustrated below by consideration of the common forms of STS that have been identified in this chapter.

In the case of DRT, the widespread successes of statutory authorities in winning substantial (pump-priming) funding under the Bus Challenge programs for the implementation of services (see Brake et al., 2004) have contributed to the establishment of many schemes which were ineligible for

[19] Although largely consistent, the governing legislation varies between the countries of the UK. Taxi based operation, including that of STS, are governed by Road Traffic Order in Northern Ireland.

the Bus Service Operator's Grant (BSOG) on any flexible route sections. In England and Wales the Department for Transport Consultation Paper entitled "The Flexible Future" (August 2002) put forward new proposals for the registration of flexible transport services (DfT, 2002). These proposals, implemented as of February 2004, permit registration according to a simple classification of service types. Subsequently, the DfT have clarified that there is now a requirement to record actual pick up and drop off times because the Transport Act 1985 requires any system of local bus service registration to be enforceable by the Traffic Commissioner. It is also important to consult with the Traffic Commissioners at an early stage on any proposals to register a DRT service as they have considerable discretion over what services can and cannot be registered and are generally sympathetic. Mileage readings are also required at the time of pick up and drop off. Crucially, BSOG has been extended to flexibly routed local bus services. However, the BSOG claim must be supported by full evidence of mileage on the flexible route sections and this may not be readily available.

Operating on a not-for-profit basis, Community Transport groups can offer registered bus services under Section 22 of the Transport Act or non registered services under Section 19. The latter (of which a typical example would be the traditional Dial-a-Ride services) enables specified types of groups to hire a vehicle (with or without a driver) in which they decide where and when the vehicle is used, but the vehicle cannot be used to 'ply for hire' by picking up the general public. BSOG was extended to Community Transport by the Rural White Paper (2000).

Statutory (local) authorities provide a range of non-registered bus services, such as education, social and other care services transport and non-emergency Patient Transport Services (PTS). Education journeys are fixed annually, with little variation from one year to the next: this enables authorities to open up some of these services to the general public by registering them. The pattern of movement of social and other care services and PTS passengers is less rigid than for education trips.

Non-registered public transport options also include two types of taxi: hackney and PHV, definitions of which are set out in chapter one.

8.4.3 Vehicle design and specification

Vehicle specification is also heavily dependent on legislation. For example, the transport section of the Disability Discrimination Act (1995) led to the introduction of Public Service Vehicle (PSV) Accessibility Regulations making wheelchair accessible low-floor buses mandatory for Section 22 services, although no formal requirements have been defined, at the time of writing, for application to taxis. It is noted, however, that a number of recommendations for an accessible taxis do exist including that of the Department for Transport (DfT, 2009) identified as a part of their consultation on access to taxis and other accessible vehicles.

8.5 Discussion: the role of the taxi in specialist transport

The use of taxis in the delivery of STS has varied, and will often depend on the forms of vehicles being used, as well as the regulatory environment in which they are supplied. The traditional small vehicle taxi has a role in the delivery of STS but is limited by the size and availability of vehicles, as well as the expectations of both the public and the operator. This limitation, rather than the actual abilities of the mode, have tended to restrict the use of the taxi as an STS vehicle even where the definition of STS is broadened beyond that of strictly medical-related.

This chapter has indicated several cases where STS has migrated to either include new STS passengers or in some cases to combine operations in a joint STS- open access provision. The Flexible Agency Concept (section 8.3.1), although still in its infancy, encourages such multiple service provision and is designed to encourage greater use of the flexible transport resources of which taxis play an integral part. These principals are carried forward into the next chapter, which considers non-traditional roles for taxis.

Chapter Nine: The use of taxis in a community and developmental role

Introduction

The chapter provides a detailed analysis of the roles currently played by taxi services away from traditional taxi work, or specialist (disability) transport. Such uses include shared taxibus services, as well as those operating between differing legislative states, collectively called 'paratransit', and including the legal Jitney and Taxibus services running in many developing world countries, and to a lesser extent in UK and US cities, including Belfast ('Black Taxis'); and those operating to serve particular needs, such as the semi-regulated and unregulated gypsy cabs in some US cities.

9.1 Non-traditional roles for taxi services

There are considerable opportunities for taxi services to serve non-traditional markets. Cooper et al (2007) coined the term "parataxi" to represent transport services provided by taxi away from traditional definitions of taxi services. They suggest that such a term should include taxibus services, as well as taxis providing general Demand Responsive Transport (DRT) and focused "on demand" services. Parataxi services might also logically extend to include

"park'n'taxi", the German Anruf Sammel Taxi, and extended reach booked services operating in combination with other forms of public transport. In contrast to these more formal examples of non-traditional roles there are also numerous examples of informal taxi-based options, often (but not exclusively) found in developing economies. Both variants are considered in this section.

9.1.1 Shared taxis

Organized shared taxi services are common in Europe. Perugia (2004) considers the characteristics of organized collective taxis drawing examples from airports and night services. This practice has been replicated around the world. Experience within the UK is fairly typical where there is legislation for shared taxi services under the 1985 Transport Act (Figure 9.1). The Act permits shared taxis on either an immediate hiring's basis (Section 10) where sharing schemes are identified by special signs at ranks or on vehicles, which one might classify as informal sharing; or in a more formal way via advance bookings (Section 11) which was discussed in Chapter eight (see Table 8.1).

DfT (2002) suggest that under Section 10 provisions passengers gain because they pay only a proportion of metered fare so more people may be attracted to use shared taxis; drivers gain because collectively they will receive more than the metered fare because the vehicle is not hired as a whole and so more people should be attracted to using their service; and local authorities gain because the number of vehicles being used on their streets should be less,

thereby reducing congestion and pollution, and they can plan where to put ranks for shared use. Benefits of Section 11 provisions include the flexibility for taxi and private hire operators to match up passengers either at pick up or on return, or both; journeys which can be one-way or return, "one-offs" or on a regular basis; passengers paying lower fares than for an exclusive hiring; operators taking more for shared journeys overall, as well as having the potential to attract more passengers because of lower fares (DfT, 2002).

The British case is instructive as there is renewed interest in the potential for shared taxis following the publication of A New Approach to Rural Public Transport by the Commission for Integrated Transport (November 2008). CfIT's analysis examines the role that taxis and other demand-responsive transport services could have alongside more conventional public transport and argues that the UK would benefit from demand-responsive transport schemes similar to those that have developed in the Netherlands and Switzerland. These schemes are similar to the "mainstream" flexible transport services discussed in Chapter Eight. However, CfIT (2008) coin the phrase 'TaxiPlus' to refer to the form of taxi-based public transport service they propose: a fleet of small vehicles that provide shared transport to passengers who pre-book.

9.1.2 Taxibus services

Cooper et al (2007) note that examples of taxibus services are relatively limited in the UK (see Scottish Executive, 2006), current examples including the Belfast Black Taxi operations, and a yellow taxibus scheme trialed in Edinburgh and Fife. Guiding legislation differs across the UK, with the most complete example of taxibus services operated under the Northern Ireland Road Traffic Order (see: DOE,2006). In Great Britain A taxibus is defined under Section 12 of the Transport Act, 1985 which states:

"If you have a taxi licence and wish to run your taxi like a bus as a local service with separate fares along a route registered with the Traffic Commissioner, either wholly or for part of the time, you can apply for a special bus licence. You will be required to register a route with at least one stopping place within the area of the local authority which granted the taxi licence. Your vehicle will need to be one for which you hold a taxi licence, display a 'BUS' sign (not an illuminated 'taxi' sign), and display a table of fares; the driver of the 'taxibus' must be licensed as a taxi driver by the same licensing authority as the vehicle."

DfT (2002) identify the stated benefits of operating as a taxibus as including increased flexibility for taxi operators; the ability to use the vehicle for normal taxi services when not being run as a bus service (i.e. the taxibus service need only be registered for certain time(s) of the day); providing passengers with a bus service when a larger vehicle would be uneconomic; offering the possibility for a local authority to make savings by subsidising a local taxibus service (rather than a larger bus service); and by allowing a taxibus licence

holder to qualify for Bus Service Operator Grant (fuel duty rebate) when running a local bus service.

One example of from a rural area is the Shilbottle Taxibus service in Northumberland in North East England which has a pool of operators, the selection being based upon availability and accessibility – although in certain cases the passenger may be permitted to choose the operator. The selection of the vehicle is made manually by the dispatcher from a spreadsheet and the schedule is sent by fax to the appropriate operator, therefore the scheduling system is not required to select a vehicle in real-time (Brake et al, 2004). This service was for a time dispatched from a common dispatch at the Tyne and Wear PTE.

9.1.3 Other paratransit

The term paratransit may be variously defined, and has a significantly different understanding in the UK compared to that in the USA. For Lave and Mathias (2000) "paratransit means alongside transit" and they go on to contrast ADA-complementary paratransit (i.e. medical-related special transport services, see Chapter eight) and all other forms of DRT. Whichever definition of paratransit is adopted the common feature is to conceptualize paratransit as an alternative to conventional fixed route transport services. Paratransit has often been associated with informal transport provision. Such shared transport services (either taxi, bus or jeep based) commonly provide

access to multiple users in areas (for example) of West and Central Africa ('Jitney'), in Central America ('Camionetas', see: Valenzuela et al, 2005) and across Asia. An early paper which established principles of good practice in developing countries is Silcock (1981). More recently, the need for greater integration between the formal and informal (paratransit) provision of public transport services has been identified as a necessary ingredient of public transport service planning. In this way public transport can provide a vital contribution to a poverty-focussed agenda and contribute towards the delivery of the Millennium Development Goals (Nelson, 2007).

Examples of formal paratransit may also be found in parts of Belfast in the UK (Black Taxi Paratransit, see: Denmark, 1998, DOE, 2006) and as 'Vernacular' cabs or 'gypsies' in some parts of the USA (see: Suzuki, 1985). Similar collective vehicles schemes are also provided beyond the reach of public transport 'verbunde' in Germany, where they are known as 'anruf-sammel-taxi'; and in rural transport services including bus-based demand responsive transport (Ambrosino et al. 2004; Brake et al., 2007).

Wright et al (2009) provide a detailed analysis of a focused on-demand service using community-based drivers and taxi companies known as Transport to Employment (T2E) which builds on the concept of shared taxi to provide an instructive illustration of the benefits to be gained by the sharing of transport resource. T2E is a centrally co-ordinated shared transport service providing access to workplace, training and childcare in the remote and rural communities of East Sutherland, Easter Ross and Southern Caithness in

Highland Scotland. A particular characteristic of the T2E service area is its remoteness and sparse population, even relatively small distances between individual and employer (e.g. 10km-25km) represent a significant barrier where transport (both public and private) is not available.

The T2E service is delivered through a centralised booking office that is responsible for planning, co-ordinating and delivering services to meet community needs. The booking office is tasked with planning routes and ordering travel services to reflect requests made to the service. Both telephone and on-line booking 20 has been adopted. Figure 9.1 illustrates the processes and information exchange between all the different actors involved in delivery of the T2E services.

T2E has sought to operate on a low-cost basis, reflecting the need to provide reliable services without imposing fare levels that would themselves become a barrier to use. This has been achieved from a user perspective as targets for the number of users have been reached and high levels of satisfaction and acceptability have been recorded. However, detailed investigation of the passenger and route details shows that the majority of the routes are not self-supporting and require significant additional funding to maintain their operation. Wright et al (2009) demonstrate that the social value created by T2E has been assessed against the project's investment (the grant funding) to assess its 'sustainability' using Social Return on Investment (SROI) analysis. This revealed that the combined benefit to individual user and the state is

[20] www.t2e.org.uk

about £9,000 per year (while the user is still in employment) and that the measurable social benefits outweigh the investment by more than 3 to 1 for current usage patterns.

(Insert Image: Figure 9.1)

Figure 9.1: Illustration of operational model for providing T2E services (source: Wright et al, 2009)

9.2 Combined carriage of passengers and goods

The combined carriage of passengers and goods is well established over many centuries. One particular manifestation of this is in the form of Postbuses which have been a traditional feature of rural communities both in Britain and on the continent (particularly in Austria, Germany and Switzerland). The British Royal Mail Postbuses carry more than 50,000 passengers a year although services have been declining for many years. There are usually two services a day from Monday to Friday to coincide with morning delivery and afternoon pickups and services may run on a Saturday morning. It is permitted to hail a Postbus at any point along its route and it will stop to pick up passengers, providing road and traffic conditions allow. Postbuses don't always travel the same route on the return journey and fares differ across the UK depending on location and distance traveled; there are concessionary fares available on all services (www.royalmail.com).

A practical example is the registration of mail delivery vehicles as Postbuses to more remote areas, such as upper North Tynedale in Northumberland. Whilst this enables some movement of the general public the time and direction of travel is not suitable for commuting purposes (Brake and Nelson, 2007). Flexibility is limited due to limited possibilities for altering the mail delivery route and time. Wright et al (2009) confirm the lack of suitability for passengers making work-related journeys noting that although postbuses are often a common feature in remote rural areas, providing a valuable level of increased mobility for some users, they are rarely suitable for access to work as they generally operate away from the centres of employment during regular morning work start times and often serve different areas on different days of the week.

The contribution of transport telematics the recent developments in DRT was discussed in Chapter eight. Similarly developments in the "information society" or digital economy have lead to the rapid expansion of the e-logistics concept in which the Internet is a major backbone (Ambrosino et al, 2005). The e-logistics concept is defined by the interaction and integration taking place in the interfaces between traditional logistics, Information and Communication Technology (ICT) and process management. E-logistics delivers total solutions that are built on virtual rather than ownership-based integration. ICT enables the creation of an intelligent value web in which individual activities are optimized based on the creation of value to the

customer. Thus e-logistics is one of the cornerstones for successful e-commerce, but it is also a key factor in e-business and the rethinking of traditional industrial enterprises.

A clear understanding of the developments in e-logistics is necessary in order to understand the applicability of these concepts in urban logistics in general and opens up new possibilities to appreciate the potential for the combined carriage of passengers and goods.

9.3 The taxi / community transport interface

There are clear possibilities for the taxi and community transport (CT) sectors to work together and share experience in the provision of flexible transport services. In Britain, under the 1985 Transport Act there are two main possibilities for the CT sector to be involved in the delivery of public transport services, namely community bus services and group bus services (see Table 8.1). These are considered below with illustrative examples.

Community bus services (1985 Act, Section 22) are local bus services run by non-profit making organisations concerned with the social and welfare needs of a particular community or group of communities, either complementing existing bus services or providing one where there is no service. Community buses are permitted to carry the general public (DfT, 2002). These services may be run with vehicles of between 9 and 16 passenger seats, on a voluntary

non-profit basis, and using unpaid volunteer drivers. Though no payment may be received for driving, reasonable expenses and payments for loss of earnings from driving in exceptional circumstances may be made. Crucially, a permit is needed from the local Traffic Commissioner and the services must be registered as a local bus service. Although an operator's licence is not required, the Traffic Commissioner will want to be assured that proper arrangements have been made for maintaining the bus. The benefits of a community bus service are identified by DfT (2002) as enabling a voluntary group to run a scheduled bus service without meeting the costs and other requirements of operator licensing; providing services tailored to fit local needs (whilst also carrying the general public) and filling a gap which is not attractive to a commercial bus operator. As with Taxibuses the vehicle can be used for other purposes when not required for a local bus service.

Group bus services may be provided under Section 19 of the Transport Act 1985. The general public is not permitted to use these services that should be provided by a non-profit making body concerned with activities for the benefit of the community (DfT, 2002). Services are usually provided for a particular social or community group, such as older or disabled people and would normally be for between 9 and 16 passengers. A typical example would be the Dial-A-Ride services described in Chapter eight. In Great Britain, a permit must be obtained from a Traffic Commissioner or in some cases from a local authority and there is no need for an operator's licence or to register a route. DfT (2000) identify the benefits of group bus services as being to enable a voluntary group to run a bus service for a particular social group without

meeting the costs and other requirements of operator licensing; and that the service provided can be flexible as there is no requirement to register a route.

Brake and Nelson (2007) in their analysis of flexible transport solutions in the rural county of Northumberland note the important role played by the voluntary sector in filling gaps in the commercial and supported transport networks. The voluntary sector is able to further fill the gaps for the disabled and elderly by providing Section 19 services and gaps for the general public with Section 22 services, but coverage is irregular (see Table 8.1 in Chapter Eight for definition of service types). Section 22 services are often designed to provide a shoppers' service, such as between Corbridge and Hexham in Tynedale, Northumberland and between Hexham and a large Tescos supermarket on the north-west edge of Newcastle upon Tyne. Dial-A-Ride services have been the province of the voluntary sector, in which the vehicle is routed according to customer demand using manual scheduling, which requires at least previous day booking. The voluntary sector has successfully worked with a "bottom up" approach, carefully identifying end user needs. However, their efforts are hampered by lack of permitted input to wider network planning, access to funds and access to sufficient vehicles to meet identified demand. Lack of flexibility in CT services often centres on the non-availability of vehicles due to the absence of volunteer drivers to meet demands.

A relevant example of what can be achieved by harnessing the potential of the taxi / CT interface is the Rural Wheels project in Cumbria (Figure 9.2) which

also provides an example of multiple service provision (as discussed in Chapter eight).

(Insert Image: Figure 9.2)

Figure 9.2: Rural Wheels, Cumbria (source: Brake et al, 2006)

9.3.1 Case Study 1: Rural Wheels, Cumbria, England

This project is funded by the former Countryside Agency, through the Rural Bus Grant and by Help the Aged in order to introduce DRT services in the south west of Cumbria, with a view to rolling the service out across the county. The associated NOWCARD Smartcard project is funded by the Rural Bus Challenge. The area covered by Rural Wheels 1 was in South Lakeland serving the rural areas surrounding Ulverston.

Management: the Steering Group is composed of Cumbria County Council, the Countryside Agency (now ceased), Morecambe Bay Primary Care Trust and Help the Aged, meeting monthly initially to plan the service. Management decisions are made by Cumbria County Council, the fund holder, who is also responsible for the interface with operators and users and reporting on Rural Wheels to the NOWCARD Smart Card project.

Service management: registered services (including S19), special transport and shared taxi service are covered by the management structure. Integration between types of services has been achieved with education and general public

trips on one service, together with a short experiment carrying social services and general public trips together.

Centralisation of management: day-to-day management of the service was initially carried out by the Cumbria Ambulance Service. This function was later transferred to be in-house at Cumbria County Council offices in Carlisle, alongside education, statutory and mandatory transport contracts, educational assessment and procurement.

Level of telematics: Cumbria Ambulance Service already dispatched Patient Transport Services users. Cumbria County Council dispatches services manually, whilst payments by passengers are made using a pre-paid contact/contactless Smart Card – removing the requirement for drivers to handle money; this is being superseded by an ITSO compliant contactless card (the NOWCARD project) with stored seamless travel rights thereby enabling a fair distribution of revenues between operators on multi-operator trips and the potential to detect passenger fraud.

In terms of developing the potential for a constructive interface between taxis and CT "partnerships" will be increasingly important. This should in turn facilitate the integration of transport services and providers which the future development of flexible transport services relies upon. In pursuit of this it is helpful to distinguish between two main types of partnership: management partnerships and brokerage partnerships (Brake et al, 2006). In a management partnership each member will have clearly defined responsibilities. The

purpose of developing a partnership is to ensure that the needs of stakeholders are understood and met, such as ensuring that commercial services are not jeopardised or that the differing functions / ethos of CT and commercial operators are recognised. Partnership extends to co-operation within organisations such as local authorities as well as between them. Even then, it takes a long time to set up new services, partly due to the different organisational structure of the entities involved; however, over time such a partnership should be characterised by stability.

The principles of partnerships to manage a standalone service can be extended to the brokerage of vehicles and staff. A well structured brokerage partnership offers the opportunity to save marginal and operating costs. The opportunities for reducing total operating costs for the partnership as a whole are very high but can be difficult to achieve if initial effort is not put into the creation of a stable partnership in which the purpose of the services and how they are delivered is clearly established. Brake and Nelson (2007) stress that in order for this to work governance issues need to be clear and based on outcomes and not inputs.

9.3.2 Case Study: Taxibus, Black Taxi Services, Belfast, Northern Ireland

A significantly differing use of taxis within the provision of local community based services exists in Northern Ireland. A number of routes operating

around Belfast are best classified as Taxibuses, and relate to the use of traditional London style taxis in multiple occupancy along predetermined "routes". Unlike the more rural examples in Cumbria, Belfast's Back taxi operation operate without a subsidy on the basis of fixed and published tariffs (see figure 9.3) and have become well established and widely used.

(Insert Image: Figure 9.3)

Figure 9.3 Fare table for West Belfast Black Taxis

Geographical Description

Taxibus services operate in Belfast, Northern Ireland, along two primary arterial corridors and provide a basis for the local terms of Falls Road taxis or Shore Road taxis. The taxibus services collectively are known as black taxis, this referring to the appearance of the vehicle, but this remains confusing with the same vehicle types in common use in other forms of taxi operation in the city, most particularly as public hire (Hackney Carriages) in the city centre.

Shore Road and Falls Road taxis remain separate and are operated independently within two taxi associations, the Shore Road Taxi Association, and the West Belfast Taxi Association. Both fulfill the functions of an organizing group, with the West Belfast association having developed a significant terminal facility at Castle Junction, situated alongside the city centre retail zone. Shore Road taxis operate from public highway using

stances in Bridge Street, similarly centrally located within the main retail area of the city.

Licensing

The Belfast Black Taxis offer a very strong example of a successful taxibus operation in a mature city location. Services are well maintained and are accommodated within the licensing structure as a separate but licensed form of taxi (see: DOE, 2006).

The primary facets of these operations are:

- Licensed vehicles, exclusively London style taxis
- Operating from a specified location within the city centre
- Operating along defined routes
- Offering multiple occupancy journeys to passengers with different origins and destinations along the same route

The taxibus has developed over time, sharing many of the issues seen in developing countries, in providing a stable form of public transport at points of time where more traditional bus services have been limited. In Northern Ireland such shortfalls were observed and common in parts of the city during periods of civil unrest ("the troubles") which resulted in widespread withdrawal of public bus services.

Absence of reasonable alternatives gave rise to community based initiatives, which in turn gave rise to the Belfast black taxi.

The black taxi developed over time and was, for a number of years, not recognized by the licensing authority, the Department of the Environment for Northern Ireland (DOE). During this period black taxis operated without license, with control imposed predominantly by the taxi associations themselves. However, the more settled political circumstances in Northern Ireland from the late 1990s predicated a number of initiatives to be realized, including the development of a "taxibus" license by the DOE.

Vehicle Type

Belfast Taxibuses are operated exclusively using London style taxis, of which the majority of vehicles are Carbodies (later LTI) FX and TX models.

The longevity of the LTI vehicles in service makes these an ideal vehicle for use throughout their lifespan, which, in some instances, can reach 30 years in taxi service. The vehicle is well suited to urban taxi operation and has an additional benefit of being cascaded through authorities areas particularly as a result of maximum age limits being applied in some areas.

The LTI, and alterative Metrocab, vehicles carry five passengers seated in the main cabin area and can carry an additional passenger with the driver. The small numbers of passengers, compared to public buses, allows for a regular and frequent service, with the typical operating pattern being to depart from the city centre terminus once the vehicle is full.

Levels of supporting Technologies

Unlike the more complex systems applied to rural routes, where booking and route planning are a necessary part of operating efficiently, Belfast taxibuses employ limited supporting technologies. Taxis effectively operate when full, or when ready, and have no need or ability to be dispatched to single journeys. The terminal facility for the West Belfast, at Castle Junction, is based on a bus concept identifying vehicles by route, see figure 9.4.

(Insert Image: Figure 9.4)

Figure 9.4 Belfast taxibuses at Castle Junction terminal

The experiences of taxibuses in Belfast can be seen as a significant example of a successful urban "shared taxi" operation. While relatively few such examples exist in the UK, the concept appears valid, and the majority of passengers interviewed in Belfast are positive about the service. Direct lessons

may be drawn as to how a taxibus operation may be designed in an urban area, with wider learning in relation to the methods of formalizing previously ad hoc service provision. The moves within the licensing authority to formalize and license Belfast Taxibuses demonstrates the potential to achieve a recognized service.

9.4 Conclusion

This chapter has considered the role of the taxi in a community and development role. There appears a clear demand for taxis to operate across a range of markets from the highest levels of premium service, to the significant community roles exampled by the Belfast Black Taxis. However, as noted in the conclusions to the previous chapters, the constraints of the regulatory involvement must be fully appreciated. In the context of taxis and other forms of personal transport a significant advance would be to understand how these different services may be included within an integrated transport policy. This would have the effect of allowing the flexible transport offer to move readily into a considerate set of options including taxis, shared taxis, Taxibus and even car clubs. The barriers to development, set out in chapter ten, influence the long-term viability of the taxi, and may act to prevent the mode achieving its full potential.

Chapter Ten: Barriers to development

10.1 Introduction

In previous chapters we have identified the historic and current roles of the taxicab, and the legislative environment in which taxis operate. This chapter develops these concepts by considering the barriers affecting the further development of the mode. This includes barriers arising from legislation, intentional restriction and accidental side effect, and those barriers resulting from operating practices, company structures and the culture that pervades within the sector. The chapter draws from examples of good practice in both the UK and the USA to demonstrate potential, as well as illustrating by case study some of the issues that have prevented developments from occurring.

10.2 Legislative requirements

It is common in a number of papers to identify "regulation" as a barrier to development within the taxi mode. This typically relates to quantity restrictions, but may also relate to vehicle types – quality restrictions, and in some instances controls affecting fares. In chapter two we discussed the background to the regulatory environments common in taxi and these are summarized here using a common terminology:

- to the numbers of vehicles licensed (Quantity Control);
- to vehicle and operator fitness standards (Quality Control); and
- to their fares (Economic Control), collectively QQE.

In both the UK and US taxi regulations follow a similar approach with cities and local authority areas defined as licensing authorities following the same guiding principles, that of protecting the public interest, with a similar argument applied wherever such controls are applied. This is in effect the key justification of regulation. Chapter Two also highlights the fact that approaches to regulation vary and tend to alternate between regulation and deregulation; the latter including de-listing – the removal of quantity controls, and more comprehensive deregulation.

Parallel to the traditional operation of a taxi, it is also appropriate to consider the "non-traditional" roles of taxis, set out in chapter nine, both as services in their own right, but also in relation to the impacts "traditional" taxi controls effect on these services. Such services include examples of semi-formal paratransit and *informal* taxi-based options. The latter "informal" taxi services are of specific interest in their developmental role, often (but not exclusively) found in developing economies. In Asia, for example, there are (approximately) 50,000 jeepneys in Manila and 24,000 taxis in Singapore. In Africa, Accra has approximately 12,000 *tro-tros* whilst in South America there are many thousands of *collectivos* in Rio de Janerio.

10.3 Operating practices

We noted in the previous section that issues relating to the regulation of taxis can be conveniently categorized within the QQE typology. Chapter three explored in detail the components of taxi market models that are commonly built around this typology. In this section we summarize the extent to which Quality control, Quantity control and Economic regulation impose potential barriers to the supply of taxi services in an operational context.

Quality control is an overarching description applied to a variety of factors affecting the quality and safety of taxi vehicles. These include vehicle safety, operator and driver fitness and comfort, and appearance of licensed taxis. We argued earlier that whilst quality controls remain the least controversial area of taxi regulation, it can be easily seen that any such restrictions can, and do, impact on the wider market in which taxis are supplied.

Quantity control is without question the most controversial element of taxi regulation. This can include restrictions applied to the numbers of vehicles and licenses issued in a Licensing Authority area. The most common form of control is a direct limit to the numbers of vehicles permitted to operate, usually achieved by placing an upper limit (cap) on the numbers of licenses issued, affecting and restricting supply. A common measurement of demand is the presence (or absence) of significant unmet demand (SUD), set out in chapters three and four, though some authorities question the appropriateness

of this measurement given the uncertainty of some of the variables, this was also described in chapter three.

Economic control is mainly visible as controls to tariffs applied to taxi fares. In this respect the term applied to the control of economic aspects of taxis should be clarified and applied in the determination of price restriction and appropriate tariffs alone. The application of price controls is justified, in most instances, as a balanced measure against overcharging by unscrupulous drivers and included in leading legislation as a requirement to review (but not necessarily amend) tariffs on a regular basis, in the UK this is defined as a period not exceeding 18 months[21].

10.3.1 Issues specific to the Night Time Economy

In Chapter Six the role of the taxi in the Night Time Economy (NTE) was explored in detail where it was noted that the NTE provides differing opportunities and challenges in comparison to the day. In transport terms, demand differs across time periods reflecting particular advantages or preferences for one mode over another by time of day. Considerable potential for conflict in the NTE exists in relation to both the use of transport and in terms of the policies applying to transport provision and we highlighted four areas of potential policy conflict exist being:

[21] Civic Government and Local Government Acts.

- Differences between daytime and nighttime impacts of the same policy;
- conflict between security and a welcoming transport environment;
- different locations within the city for day/nighttime activities; and
- boundary and institutional conflict.

While it is apparent that transport plays a significant role in the city across day and night time periods, it may be concluded that the NTE is broadly underplayed in the development of transport policy and this remains a further barrier in the role to be played by taxis.

The development of transport policies appropriate to the needs of all transport users is a significant factor in ensuring appropriate development of services into the future, and facilitating economic growth and social interaction. The needs of a NTE do not necessarily mirror the needs of the daytime city, and the danger arises that policies drafted to meet the needs of the daytime economy may fail to meet the aspirations of the night time city or even work against its needs. Issues of supply are also pertinent. The majority of UK cities identify an issue in the supply of taxis and a pattern of steeply peaked demand is observed at 1am, and again at 4am, matching departure from pubs and clubs to seek transport home. Fridays and Saturdays are identified as problem evenings, with the majority of demand outside these peaks being sufficiently well served. Such peaking leads to a conflict of interest between the need to address insufficient supply to meet demand on Friday and Saturday nights and

the potential for excessive supply during the day. The dichotomy is significant and differing approaches to address either issue can present problems.

Issues in the provision of daytime transport, most particularly congestion, access restrictions and a desire to promote certain forms of public transport are far less likely to apply with the same weight in the NTE, where private car use is reduced, congestion minimal and most public transport unavailable. It would appear beneficial to develop policies specific to the needs of night as well as daytime use of the city, and to ensure that transport policies being developed in one arena are positive to the activities of the other.

It is desirable, therefore, that transport policies take account of the full range of their impacts, in both day time and night time economies. Tools are required, including a standard method of assessing impacts arising from policy application across temporal as well as spatial boundaries, establishing individual impacts as well as corporate effects. Without these important developments barriers to the fuller contribution of the taxi to the NTE will remain.

10.3.2 Issues specific to the market for Specialist Transport Services (STS)

Chapter Eight considered the role of the taxi in the Specialist Transport Services (STS) market noting that the term has been applied in a variety of contexts; most commonly special needs (often medical-related), and

frequently referring to the transport requirements of elderly and disabled. Although there have been modest examples of vehicle brokerage and combined trip types (examples including, Nexus - the Tyne and Wear Passenger Transport Executive; and Transport to Employment (T2E)in Highland Scotland). Nexus combines operating contracts for their Care Service and DRT services dispatched via a common dispatch centre and branded as *"LinkUp"*. T2E provides an alternative form of specialism aimed specifically at increasing access to job opportunities. Other examples / variants include: Strathclyde Passenger Transport's open access Ring and Ride services which may also be used by registered Dial-a-Bus users; and the "Wheels to Work" schemes which provide scooters to allow access to the workplace.

The true potential of open access DRT and other forms of Flexible Transport Service (FTS) including a more innovative use of taxis as a contributor to sustainable mobility remains to be fully exploited – partly because the necessary supporting frameworks required to deliver more effective and competitive transport solutions are not yet fully understood. The potential for FTS has important implications from the viewpoint of transport logistics and the environment since there are considerable opportunities to reduce road traffic, to save operating costs and to increase the level of service experienced by passengers.

10.4 Business structure

Further to the barriers existing as a result of legislation, it is observed that business structures also impact on the ability of a taxi business to develop. The variety of business structures in the taxi industry was highlighted in Chapter One, both in terms of their constituent market types (segments), and the form of companies operating. Market segments are noted in that taxis can provide services for different constituencies with the two most popular taxi categories (Hackney Carriage[22] and PHV) providing services to three market segments: hailed journeys, journeys engaged at taxi rank, and taxi journeys booked in advance. We have also discussed taxibuses and limousines noting that the idea of a shared small vehicle, however, owes much to the "Jitney" which frequently provides collective transport in developing countries and may be characterized by an owner-driver business structure (Chapter Nine).

The structure of the taxi market was also analyzed in Chapter One. Firm types identified in the US market vary between the total taxi company, responsible for the majority of operational and personnel functions of a large employer, to the permit only lessor, a single individual responding independently with their own account. The result is a continuum of operating patterns varying between taxi company orientation and individual driver orientation. This has impacts for the both the industry and the customer with independent drivers, for example, being free to decide whether or not to accept dispatched trips (where there is the availability of radio dispatch), and the controller offering, rather

[22] Small Public Service Vehicles in the Republic of Ireland.

than instructing, a passenger trip. Whilst "taxi drivers as employees" is a costly option there is a trade-off to be made against loss of control over drivers where other business structures are adopted (e.g. taxi firm/vehicle lessor) which may result in drivers declining bookings and / or engaging in excessive hours. The range of company structures will also impact on the licensing authority in relation to the extent of controls applied centrally by the authority, and those within the power of the operator.

10.4.1 Alternative structures - the Agency approach

The *Agency* approach to multiple services provides a logical extension to the structures in place and operated by single companies. The concept is discussed in Chapter Eight in relation to specialist services, where it was noted that the appropriate use of telematics can assist by enabling an additional level of management information with the possibility of a real-time dimension. Figure 10.1 depicts the evolving framework for DRT (see Nelson et al, 2005) and which can be used to illustrate the barriers facing the widespread deployment of FTS. It is also appropriate to note that locations operating a large number of small companies (US: permit only lessor) may also benefit from the centralisation of booking functions, with wider examples of this practice existing in Finland and Austria.

The development of a telematics structure in FTS has already been achieved (as illustrated by Chapter Five) and a number of key principles have already been established, including those set out below.

There must be an effective, reliable means for the potential user to communicate travel demand. This requires booking and reservation systems capable of handling multiple and diverse requests, with quick turnaround time; supported by databases to manage and support the booking process. Computerized scheduling and assignment tools have become common to the industry and ideally should possess the functionality to generate, adapt and update service trips (routing and timing); assign and where necessary reassign passengers; assure that customer time windows were respected; and respect upper limits for distance and time deviations.

Dispatching tools require the capability to create and update instructions for drivers and this implies communications platforms to support the appropriate exchange of information. Overall, there should be a clear emphasis on minimizing the overall resource requirements.

The requirements for a comprehensive 'organizational' structure are equally well understood and, in respect of an "Agency" approach can be set out along the following principles:

- The actors provide a 'seamless' service to the user
- Virtual or actual agency at the core – B2C/B2B model

- Virtual agency finds the business, allocates and optimizes the work
- Multiple operators provide services on contractual basis to the agency
- Mix of full-time and as-required operators
- Operators deliver service to location and quality standards, trust the virtual agency
- Volume of available transport exceeds 'critical mass' needed to attract customers
- Agency can act on 'peer-to-peer' basis with other modes or other agencies

Probably the greatest remaining uncertainty surrounds the development of appropriate business models. A number of such models exist including those explored in detail in the CONNECT project (CONNECT, 2005a), and in relation to Transport to Employment (Cooper et al 2008). Figure 10.2 illustrates an operating framework in which the FTS could be provided.

We could describe the **Context** in the following way:

a) There is a **Framework** in place. This includes the legal and regulatory framework, the institutions, public financing arrangements, fare restrictions etc. This varies across locations, and must be taken into account. The actors cannot easily change this, and even then change is more likely to be in the medium- to long-term. Thus, the Framework forms the core constraints or 'boundary conditions'.
b) There is a **Potential Market** for mobility services. This describes the population, their characteristics, their location and the location of potential

destinations. It is also something the actors cannot easily change in the short term, although occasionally a step-change can occur (e.g. a new major employment centre, significant demand management measure). The Potential Market should also be considered as background.

c) There is a set of **Market Opportunities** which are subsets of the Market. These are areas of the market with higher potential for existing actors or new entrants to gain new business. They occur due to unmet or poorly-met mobility needs. They can also occur where an actor can offer a (perceived) step change in quality, thus targeting existing business. The set of Market Opportunities is normally background, but it can be influenced by the actors, even in the short term. They can do this through outreach, marketing, and other proactive measures.

d) There is a set of **Perceived Market Opportunities**. In a perfect world, this would align fully with the Market Opportunities. The Market Opportunity which is being assessed – and hence the Service Offer and the Business Model – is based on what the actors perceive to be the case. If there is a significant mismatch, this could have profound implications. There are four factors which can cause a sub-optimal alignment :

   a. Actors might not be aware that a market opportunity exists
   b. Actors have insufficient information, underestimate the scale of the opportunity, and wrongly dismiss the opportunity
   c. Actors see an opportunity, but misread some aspect of it. Hence, their response to the opportunity is not well matched to the reality
   d. Key actors – normally the public sector – have a specific agenda which is not at all related to the Market, or only to specific groups

e) There needs to be a set of **Interested or Mobilised Actors**. These are the actors who have perceived the Market Opportunity/ies and are willing to take actions. If this set does not exist, then there will not be any FTS. More importantly, the nature of these actors, their motivation, their capabilities, their innovation and risk-taking characteristics, their ability to work together, and the resources they can mobilise are all key to the form and scale of FTS which can emerge.

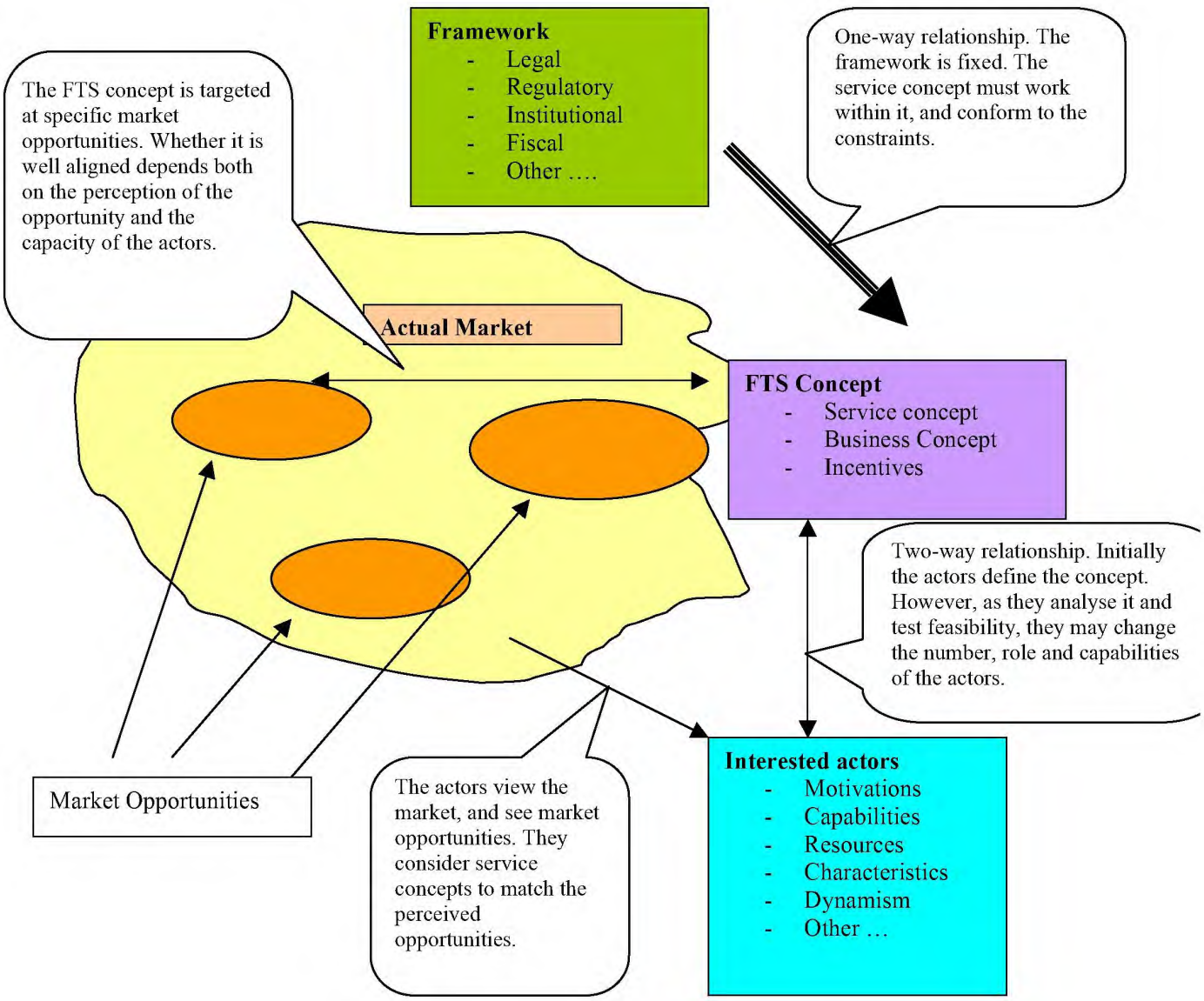


Figure 10.1: Relationship of context and concepts in a possible FTS business model (source: CONNECT, 2005)

10.5 Conclusions

This chapter has explored barriers to the further development in of taxi services suggesting that these can be categorised to some extent by legislative requirements, operating practices and business structure. Taken together a number of areas for further investigation may be identified:

1. In the context of taxi and other forms of Flexible Transport Services (FTS) a significant advance would be to understand how to include other services within an integrated transport policy, thus extending the options to include door-to-door bus travel, shared taxis and car clubs within a common set of flexible options.

2. As information technology improves, the opportunity to introduce such a set of flexible transport options where demand and supply are better matched increases; the Virtual Agency model presents an attractive means of achieving this. It is important to bear in mind that many technological solutions are available and that these do not preclude simple options (e.g. a TDC, GSM network and in-vehicle mobile phone). There is however a need to gain a

greater understanding of the technological, organisational and operational requirements that are needed within the context of more proactive approach to mobility management which exploits the overall range of transport resource available.

3. Within the context of environmental assessment, the evidence as to the benefits of more flexibly organised fleets using a mix of vehicle types is not yet proven. There are clear benefits from the substitution of car trips by public transport trips if higher occupancy is achieved. But, if a taxi, for example, travels to pick up a single passenger instead of that passenger using a car, there might be adverse affects from dead mileage. So a key to creating environmental benefits might be the creation of higher vehicle loadings. Environmental benefits may also come from the use of more environmentally friendly vehicles being used for public transport use as opposed to older, more emission prone vehicles of the individual. These issues require further research.

4. On the demand side there is a need to understand how to provide an integrated public transport network that uses a mix of services that users are willing to pay for and for which low income travellers are not penalised. This requires an understanding of travel behavior, the role played by fares in demand and further research on how to target subsidy at the low income transport disadvantaged rural resident. Perhaps more importantly it requires a clear appreciation of the kind of eco-sustainable and socially beneficial transport

which will enhance the status of public transport as a viable alternative to the private car.

5. From an evaluation perspective, issues surrounding the partnership of different agencies that could come together to provide vehicle supply and the pooling of subsidy funds requires research. Whilst there is evidence that transport agencies can join forces, there is no real understanding of how to create strong governance so that partnership between providers is long lasting.

Chapter Eleven: Taxi Transport: Toward a Future direction

Introduction

The future direction of taxi services will continue, as in the past, to owe a great deal to its previous development, the extent of regulation, and the extent of the industry itself to emerge and innovate. Taxis have, as a small vehicle form of public transport, emerged as significant to the delivery of local access, and this is likely to continue, indeed accelerate as the potential for the market becomes clearer and as regulators continue to broaden service potential.

11.1 A Historical perspective and current supply.

In chapter one we considered the history of the taxi as the first licensed form of public transport, charting the development of the mode from Horse drawn vehicles, including the optimization of the horse taxi and Hansom cab, through early electric and later petrol and diesel vehicles. This established an initial indication of the taxi as a service rather than a specific vehicle type. We also charted the development of the taxi as a controlled form of transport, with the introduction of licenses, their restriction in number, and the allocation of specific quality controls. Indeed, we might even suggest that current provision

varies only slightly, with the advent of new vehicles, from the structures put in place over 300 years ago. Today's arguments remain much the same as those forwarded in 1654 in the UK for a control, and those following with the cycle of regulation and deregulation. This is, of course, an over-simplification of a more significant, or rather a more complicated set of interactions that have not, as yet (and indeed may never) achieve the equilibrium of a perfect form of supply, but continue to reflect the dichotomous needs of protection, support and market freedoms.

So what can we learn, and what do we see as the fundamental building blocks on to which future development may occur. Clearly these include the arguments as to regulation. These are set out in more detail below, but are largely argued as relating to a need to control in the public interest, in terms of the quality of vehicle, the cost of use and the numbers of vehicles that may operate. The argument will also diverge along the lines of the forms of transport being provided, with a simple reference to a taxi as the vehicle permitted to carry individuals and small groups on demand. The reality even here is that the operation of a taxi splits between the immediate hires of the Hackney, pre-booked markets of the Private Hire Vehicles, and the possibility of operations as taxibuses or limousines. Recent developments require us to expand this further to include the specification of a Demand Responsive and a Specialist Transport category, though these in reality may fit within the original four definitions. Final categorization is unlikely to follow as definitive as the operating environments alter over time.

The same issues, those that have developed over time (indeed over centuries) represent current realities, and inform the current development of the mode. The history of the taxi plays an important role in its current and future forms.

11.2 To regulate or not to regulate

One of the most intransigent issues arising throughout the history of taxi provision has been the extent to which the mode should be controlled. In Chapter two, and in subsequent chapters, we addressed issues specific to regulation. The discussion is important, and inevitable in a text addressing the development of the taxi; though the reference to "regulation" as a single issue remains misleading in that it covers three potential areas of control (QQE), and might suggest the need to (de/re)regulate across all areas at the same time. The discussion is long standing, regularly (but infrequently) prosecuted, and often leads to severe disagreement between those seeking to deregulate, and those wishing to maintain controls.

In chapter two, which addresses the main forms of regulation, and in chapters three and four which address the analytical tools often applied to support differing views of regulation, we have attempted to remain neutral on the question. Indeed, it is quite likely that no absolute answer can be derived as whether to regulate or deregulate the supply of taxis. We do however, identify that certain forms of regulation appear to serve the operation of specific markets better than others. In other words, that the most appropriate forms of

regulatory control remain inexorably tied to the forms of supply desired, forms of supply apparent, and forms of supply experienced in the past. This supports the pattern, observed in the UK, where larger metropolitan cities appear to operate well under regulation, while non-urban authorities have widely deregulated; in this instance having removed controls on the numbers of licenses. Similar patterns are visible across the USA, and in a number of other western countries, with notable exceptions including the Republic of Ireland, which has removed (nationally) entry restrictions including those in place in the capital city, Dublin: In the Irish case this reflects a national (state level) approach to the delivery of taxi services, rather than the more common delegate decision making occurring at regional and local levels.

Differing levels of authority may also impact on the effectiveness of the controls being applied with differences in the UK between the majority of taxi regulation applied at regional and devolved government levels, applied by licensing authorities (devolved powers) and legislation including disability access powers, maintained nationally by the Westminster government (reserved powers). US regulations follow a similar pattern of quantity controls applied to taxis at a city level, and to limousines or car services at a state level. Subsequent confusion allows for the operation of widely differing policies in close proximity and may in some instance allow for the avoidance of control by suppliers taking advantage of inappropriate loopholes. Here then is an area of continued and future discussion. The need to regulate, and the need to ensure appropriate controls remains a key element in the future direction of taxi control, as indeed it has remained for the past 300 years.

11.3 Analytical Tools

The discussion to maintain or remove regulation also impacts on the nature of analysis applied to the mode. Specific to the UK and in some parts of the USA an analytical approach has emerged, centered on the operation of taxi models, repeatable processes, designed to determine the effects of changes in the controls applied to the market. Taxi models, presented in chapters three and four, can be applied in support of a market structure, to identify the appropriate market structure, or to assess the extent to which controls may be modified and with what impact.

Political processes may also affect the nature of analysis undertaken. The development over the last 20 years of a model of unmet demand in the UK, based on an Index of Unmet Demand (ISUD), can support the implementation of a controlled market, or identify the point at which to exit from such controls. It can also be used to observe the effectiveness of the uncontrolled market, but has generally been ignored in the latter role.

ISUD does not in itself provide the basis for a continued and oligopolistic abuse of a closed market, but rather has the potential to identify the levels of vehicles required with which to match identifiable demand.

Therein, however, lies the significant failure of the ISUD approach. That the majority of assessments have in the past, addressed patent demand, that that can be easily identified and quantified, while tending to ignore latent (or hidden) demand for taxis, including that suppressed through perceptions, as well as that suppressed through a genuine lack of supply. Similar arguments are attributed to the need to supply an appropriate number of accessible vehicles, both in the UK, where taxis have remained outwith the meanings of the DDA, and in the USA where the carriage of individuals under the ADA differ and require a separate supply of specific vehicles. The tools applied to the determination of supply and demand have, deservedly, come under increased scrutiny, and will remain so as the understandings of taxi market dynamics continue to evolve. This is not to say that the tools are incorrect, or even that their application has been inappropriate, but rather that the concept of an analytical model applied to the taxi trade offers a number of additional opportunities not fully realized in current application.

Two main areas of potential remain broadly undeveloped. These being, the extension of the basic demand and regulatory models to cover a wider cross section of impacts, and the development of a more inclusive approach to using taxis in wider transport provision. Current models, detailed in chapter three, address the demand for taxis separately to factors affecting supply, including tariffs and vehicle costs. In reality these are related and may be, should be, addressed as elements within the same analysis.

It is also appropriate to suggest that the taxi has remained largely outside traditional transport assessment, and indeed outside provision of wider services including STS and DRT. This has been to the expense of the taxi trade, and at may have the impact of reducing the levels of services available to the public. Wider consideration of the roles and potential future uses of the mode will affect the nature of models previously discussed, and revolves around the extent of innovation within the industry and applied to the industry.

11.3 Innovation

Innovative approaches in the supply of taxi services may also affect the traditional certainties of a controlled versus a derestricted market place. Advances in both booking and communications technologies open the potential for a significantly improved matching of supply to demand, though this in turn is affected by fragmentation within the industry. Traditional distinctions between the Hackney and Private Hire markets are also diminished as the intending passenger gains access to cell phone and internet booking for the vast majority of PHV operators.

Innovation also is apparent in the reach of taxis, with the increased popularity of taxis as taxibuses and the application of taxi vehicles in new market segments including as rural transport in fill, and in assuming the roles previously served by larger (albeit empty) bus services.

The extension of the taxi to taxibus provides a good example of the opportunities available that may ultimately see the taxi operating as a mainstream part of public transit.

11.4 Future

The extent of the history of taxi services, and the nature of development within the industry, suggests a mature market evolving from the patterns in which it has operated for centuries. To suggest a revolutionary approach may be premature, even foolish. This said, the mode continues to develop and demonstrate a significant ability to reach markets poorly served by other modes, and these should provide a focus for future development.

The role of the taxi at airports may also develop as the demands of an airport change with the nature of air services being used. A current move from legacy to point-to-point carriers may influence the nature of demand, as might the charging mechanisms in place within the airport campus for access and space management.

It is also likely that the continuing and long running argument between regulated and deregulated markets will continue. A continued pressure appears to exist, at the time of writing and specific to the UK, toward de-restriction. The impacts of such a move will continue to unfold and may, in time, necessitate a new approach to analysis, applying the issues of wider market

control to a deregulated supply. Similarly pressures continue to build to facilitate all disabled users within a better vehicle, or by provision of better infrastructure at stand.

Whilst reflecting a variety of histories, and remaining the oldest form of controlled transport in the world, the taxicab continues to offer a unique and very modern transport service.

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