Synthesis and Taxonomy of Systems used to Generate Revenues to be used for Highway Construction and Maintenance

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Fuel tax is the major funding mechanism for the maintenance and construction of the road networks in the US. This funding mechanism has served its purpose for a long time; but failed to do so in recent years due to the issues related to demand and the effects of inflation on revenues. With the increasing construction and maintenance costs for roads and the shortage of budget in most of the states, alternative revenue generation systems began to emerge. These systems are being discussed at different venues as possible long-term solutions to address the increasing needs of the highway program and the funding shortfall. There are newspaper and journal articles about different alternative revenue generation systems, discussing their advantages/disadvantages and applicability. However, there is a need for a study that investigates and synthesizes the literature on the main alternative revenue generation systems in an effort to develop an appropriate taxonomy to differentiate one system from another and to identify the overlaps between different systems as some of these systems have a number of similarities. This study investigates alternative revenue generation systems and generates a synthesis and taxonomy in an effort to develop a better understanding of these systems.

Key Words: Highway Trust Fund, revenue generation systems, tolling, vehicle miles travelled

Introduction and Background

The US Highway Trust Fund (HTF) was established by the Highway Revenue Act in 1956 to finance the construction and maintenance of the National System of Interstate and Defense Highways and also as the source of funding for the remainder of the Federal-aid Highway Program. HTF is mainly financed by the collection of federal excise taxes on motor fuel. The taxes dedicated to HTF are extended periodically by Congress through various Acts such as Intermodal Surface Transportation Efficiency Act (ISTEA), Transportation Equity Act for the 21st Century (TEA-21), and Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU). The allocations from the fund back to the individual States for their highway construction and maintenance are calculated using the formulas determined by these acts. Through the use of HTF, it is desired to ensure that each State receives approximately as much money back as it contributes to the fund in excise taxes (Rask, 2004). However, this does not happen all the time, making some states either (i) seek alternative revenue generation systems to fund the construction and maintenance of their highways or (ii) limit the amount of money they can spend on their highway programs to the levels below what is needed to build and maintain highways (Rask, 2004).

In 2008, HTF account faced a risk of deficit and was supplemented with an $8-billion transfer from the general fund in September as approved by the Congress. As a result of this budget deficit, many State Departments of Transportation (DOTs) could not acquire all their needs to finance their highway programs; only a portion of their needs were directed to them as per the Highway Trust Fund budget availability (Ichniowski, 2008). A similar risk of deficit resulted in a $7-billion infusion to HTF in August 2009 to keep the highway program at its current level (Ichniowski, 2009).

These deficits simply mean that HTF is unable to collect enough fuel tax revenue to pay for the needs of the highway program. This can be attributed to a number of issues: (i) the fact that the federal excise tax on the fuel has stayed the same since 1993 despite inflation and increasing needs on the highway program, (ii) the decrease in the vehicle miles travelled due to recession in the economy, and (iii) the increase in the utilization of fuel-efficient vehicles or alternative fuels. In 2001, the federal excise tax on the fuel generated around six cents per vehicle mile travelled; however today it only generates three and a half cents. The deterioration in the HTF income coupled with the increase in the cost of maintenance, operation, and construction, has created the shortfall in HTF as discussed above (Samuel, 2007).

Fuel tax is the major funding mechanism for the maintenance and construction of the road networks in the US. Fuel tax is divided into two components: i) The Federal tax with a current value of 18.4 cents/gallon and ii) state taxes that could be as low as 8 cents/gallon as in Alaska or as high as 35.3 cents/gallon as in California (Tax Foundation, 2009). This funding mechanism has served its purpose for a long time; but failed to do so in recent years due to the issues related to demand and the effects of inflation on revenues (Transportation Research Board, 2009).

Given that the current funding mechanism for highway programs mainly relies on the collection of fuel taxes which is prone to become less and less reliable (due to the reasons discussed above) as evidenced by the repeated shortfalls in HTF, it is time to evaluate the alternative revenue generation systems needed to construct and maintain the large network of US highways.

Problem Statement and the Need

As discussed in the previous section, the revenue generated through fuel taxes has been significantly declining due to the increasing fuel efficiency of vehicles and the decline in the fuel consumption. Furthermore, the buying power of the collected fuel taxes has also been declining due to the fact that the federal excise tax on the fuel has stayed the same since 1993 despite inflation. With the increasing construction and maintenance costs for roads and the shortage of budget in most of the states, alternative revenue generation systems began to emerge (Gilroy & Pelletier, 2007). Some of these systems have been around for a long time (nevertheless not utilized frequently) while others are rather newly-developed systems which have been implemented only a few times in pilot projects. These systems are being discussed at different venues as possible long-term solutions to address the increasing needs of the highway program and the funding shortfall. There are newspaper and journal articles about different alternative revenue generation systems, discussing their advantages/disadvantages and applicability. However, there is a need for a study that investigates and synthesizes the literature on the main alternative revenue generation systems in an effort to develop an appropriate taxonomy to differentiate one system from another and to identify the overlaps between different systems as some of these systems have a number of similarities.

Purpose and Scope

This study investigates the main alternative revenue generation systems and generates a synthesis and taxonomy in an effort to develop a better understanding of these systems. The taxonomy developed by this study is intended to differentiate one system from another and to identify the overlaps between different systems. The study relies on a thorough literature review on the systems that are used in the US as well as the ones that have not been adopted in the US and/or have not been widely used in the US. In short, this study’s overall purpose is to develop a taxonomy and a better understanding of some of the main possibilities that can be utilized in financing the construction and maintenance of the highway system. It is important to note that these possibilities are used in addition to the existing scenario which mainly relies on the collection of fuel taxes.

It is important to note that this study only focuses on the fundamentals of the main alternative revenue generation systems to be able to generate the taxonomy; and underlines the basic concept behind each system by discussing how each system works. This study does not investigate, in detail, the technology requirements for these systems as well as the public opinions and perceptions about these systems.

Taxonomy of Revenue Generation Systems

Figure 1 illustrates the classification of different revenue generation systems as established by this study. Figure 1 is followed by a brief discussion of each of the revenue generation systems depicted in such figure to give a basic overview of those systems. Furthermore, the overarching theme “Congestion Pricing/Value Pricing”, which consists of different schemes as depicted in Figure 1, is also discussed in this paper.
The classification in Figure 1 is developed as a result of the thorough literature review on the revenue generation systems for highway programs. It is important to note that parts of this classification are adopted from the classification by Lewis (1993) which is based on the categorization of road user charging into indirect and direct (Lewis, 1993). Nevertheless, the classification established by this study significantly differs from the one made by Lewis (1993) as the classification established by this study is more comprehensive than the one developed by Lewis (1993) and captures newer alternative revenue generation systems such as the Vehicle Miles Travelled concept, and the High Occupancy Toll concept.

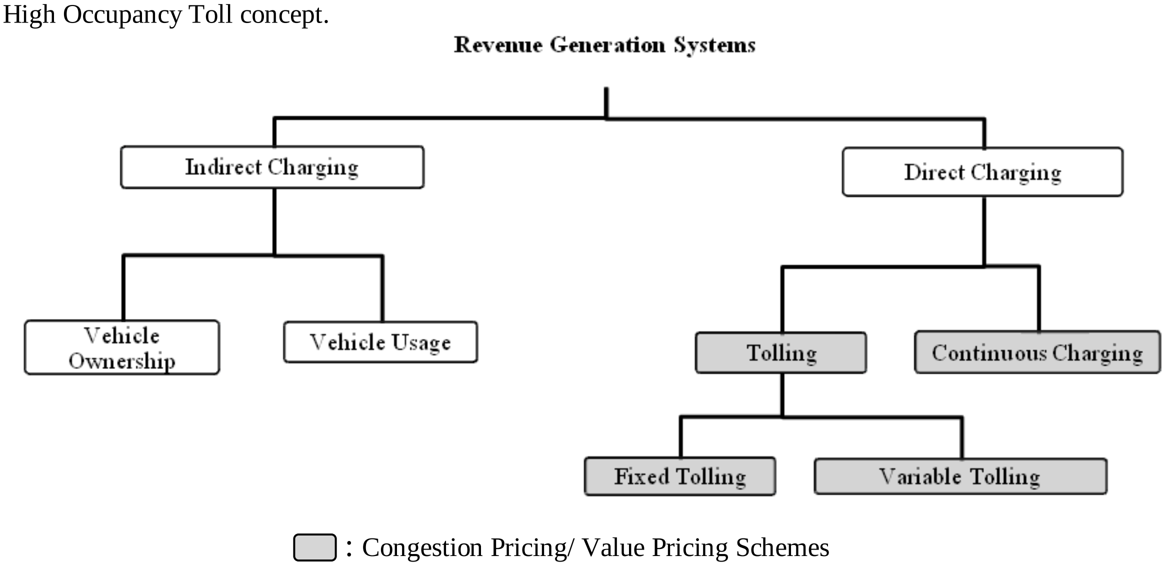

Figure 1: Classification of revenue generation systems as established by this study

Investigation of Revenue Generation Systems

This section discusses the revenue generation systems that are depicted in Figure 1. While the focus of this paper is alternative revenue generation systems, some basic information about the traditional revenue generation systems such as taxes and fees are also presented in this section to: (i) present a complete discussion on the systems presented in Figure 1 and (ii) differentiate- and identify the overlaps- between different revenue generation systems, both the alternative and traditional systems.

Indirect Charging

Indirect charging has two components: (i) Vehicle Ownership Charges and (ii) Vehicle Usage Charges (Lewis, 1993). Vehicle ownership charges are mainly composed of sales tax and annual registration fees. Ownership charges can be considerably high as illustrated in the case of Singapore. Singapore applies import duty on the vehicle’s cost, a basic registration fee as well as an additional registration fee which is 150 % of the vehicle’s cost, and an annual road tax assessed according to the engine size (Lewis, 1993). Furthermore, there is a surcharge of 10-50 % of the road tax if the car is more than ten years old. Vehicle usage charges mainly include fuel taxes and taxes on tires (Lindsey, 2003).

Direct Charging

Direct charging includes complex systems of application and can further be classified into two categories: (i) Tolling and (ii) Continuous Charging.

Tolling

Toll is a term used to define a fee charged to drivers using a certain facility (Spock & Liff, 1998). Tolling involves the collection of tolls either through manual tolls or electronic tolls. US has a long history with toll roads that goes back to the 18th century; and US, currently, is the country with the largest number of toll roads (Holguín-Veras et al., 2006). Tolling, in general, can be used for two main reasons. First, it can be used to generate income that can be used to cover the operation and maintenance costs (Ferrari, 2002) as well as to pay for the cost of construction by allowing debt financing (i.e., to serve as a source of funds to retire debt over time). It can also be used as a tool for increasing the travelling cost over a certain portion of the network for the motorists, causing some of them to seek alternative routes or modes of transportation (to reduce their travelling expenses), consequently resulting in less congestion. Regardless of the initial motivation, imposing tolls ultimately generates revenue. Tolling has different features and methods of implementation and thus is categorized into two main schemes: (i) Fixed Tolling and (ii) Variable Tolling.

Fixed tolling. There are different methods for calculating the fees collected through tolls. Fixed toll rates are generally based on a forecast study for the expected volume of travelers over a certain road portion and its forecasted operation and maintenance cost. The income generated from the toll should, at a minimum, finance the operation and maintenance costs. A fixed toll rate is commonly a combination of different parameters such as the vehicle type (e.g., passenger car, commercial truck, bus, etc.), number of axles, the weight of the vehicle, and the distance (i.e., number of tolled segments) travelled on a toll road (Spock & Liff, 1998).

Variable tolling. In addition to the fixed-toll highways in which the toll rate is fixed (even though determined by a number of parameters as discussed above) there are variable-toll highways whose toll rates depend on more complicated calculation methods and are variable depending on the location, time of the day, and number of passengers. The "time of day" and "location" parameters were the bases for the development of the "Cordon/Area Pricing" concept; and the "number of passengers" parameter was the basis for the development of the "High Occupancy Toll" concept. These two examples of the Variable Tolling scheme are explained below:

Cordon/Area Pricing: Cordon/Area Pricing is based on charging a fee to drive within a congested area (Federal Highway Administration, 2006). Cordon/Area Pricing is designed to charge drivers for using a certain road, but the rates assessed can be variable in accordance with the peak times and zones (Spock & Liff, 1998). To provide a better explanation of the Cordon/Area Pricing concept, following paragraphs discuss a number of Cordon/Area Pricing implementation examples from around the world.

Stockholm started its Cordon/Area Pricing scheme in 2006. There are 18 control points located at Stockholm city entrances and exits. Vehicles entering these zones are monitored by cameras that identify the plate number. The cost for passing a control point is SEK 10, 15 or 20 and it depends on the time of the day (SEK 10 is approximately $1.4). The maximum amount payable per vehicle per day is SEK 60. The charge is applied during daytime and no charge is applied in the evenings or at night nor on Saturdays, Sundays, public holidays or the day before a public holiday. Several exemptions account for almost 30% of the vehicles passing the zone. These exemptions include taxis, buses, and alternative-fuel cars. It is important to note that the implementation of this system resulted in an increase in the use of public transportation services and thus a decrease in the revenues collected from fuel taxes. Nevertheless, the revenues gathered from tolls were well above the loss in revenues from fuel taxes and the administrative costs associated with the implementation of this system combined (Eliasson, 2006).

One of the most well-known examples of Cordon/Area Pricing is the "London Congestion Charge" adopted by Transport for London (TfL) on February 2003 (Litman, 2006). This charge is a fixed daily fee applied to all private cars entering a predefined zone in Central London from 7:00 am to 6:30 pm on Monday-Friday (Litman, 2006). It is important to note that the fact that the fee that is charged is fixed does not mean that this revenue generation system can be categorized as fixed tolling for the purposes of this paper. The fee, even though being fixed, is only assessed during certain times of the day and certain days of the week, making this system qualify as a variable tolling system as discussed above. The daily fee is GBP 8 (GBP 1 is approximately $1.6) with some exceptions. The exceptions include public transportation buses, police cars, taxis, ambulances, motorcycles, and alternative fuel vehicles (Federal Highway Administration, 2006; Litman, 2006). When discussing this Cordon/Area Pricing scheme as an alternative revenue generation system, the sizeable initial investment needed for controlling all accesses to the zone throughout the day as well as the monitoring and administrative costs should be taken into account. However, this system has proven to be successful for generating revenue. In 2007/2008 fiscal year, this system generated a total revenue of GBP 268 million and the operation cost was GBP 131 million, resulting in a net revenue of GBP 137 million. The net revenues are used for different projects as improving the bus services, roads and bridges, road safety, and walking and cycling services (Transport for London, 2008).

The Singapore experience in Cordon/Area Pricing is considered the first one worldwide. The system was introduced in 1975. Initially, road users were charged only for morning peak hours (from 7:30 am to 10:15 am) during weekdays. Then by 1989, the city applied new evening hours from 4:30 pm to 6:30 pm. In 1994, the inter-peak hours were included and the charging became in force all weekdays from 7:30 am to 6:30 pm (Keong, 2002). The scheme has proven to be successful in generating revenue, reducing traffic, and increasing speed in the zone dramatically. The system has decreased the traffic during rush-hours by 45% and increased traffic speeds by 20% (Currier, 2008)

In August 2007, the United States Department of Transportation announced it would provide New York City with $354.5 million to proceed with a Cordon/Area Pricing system in Manhattan (Currier, 2008). The system was proposed to be monitored via electronic E-Z Pass charging system already in place. Cars entering a certain zone on Monday-Friday between 6:00 am and 6:00 pm were to pay $8 ($21 for trucks). Cars moving within the zone only were to pay $4 per day ($5.50 for trucks) (Currier, 2008). It was anticipated that the plan would reduce traffic by 6.3% and increase average speeds by 0.6 miles/hour within the zone. The revenues were estimated to be $380 million per year initially, increasing to $900 million per year by the year 2030 (Currier, 2008). Nonetheless the proposal did not succeed as it was never put to a vote on the New York State Assembly.

High Occupancy Toll: The "High Occupancy" term was derived to account for the number of passengers in a vehicle. The concept of "High Occupancy Vehicle" (HOV) evolved from that term with the idea of encouraging people to share vehicles. For promoting the more efficient use of existing capacity of their networks, many transportation agencies have adopted the idea of either reserving a lane or building separate lanes (HOV lanes) for vehicles with two or more passengers. HOV facilities are meant to provide buses, carpools, and vanpools with predictable travel times over the HOV segment (Turnbull et al., 2006). HOV concept encourages travelers to drive along with other passengers rather than driving alone. There are different types of HOV facilities. One example is the exclusive freeway HOV lanes which are completely separated from the mixed traffic by means of barriers or wide buffers (Turnbull et al., 2006).

HOV concept has been a launching point for an alternative revenue generation system. This system is called "High Occupancy Toll" (HOT). Not all HOV lanes have proven to be effective as in certain cases only a small portion of the vehicles use HOV lanes. HOT lanes offer a solution for underutilized HOV lanes (Li, 2001). In general, HOT lanes are limited access lanes for HOVs but can be accessed by Single-Occupant Vehicles upon paying a toll (Gilroy & Pelletier, 2007). HOT is not a fixed toll rate as it is meant to ensure that traffic is flowing with a minimum speed at all times. HOT rate is dynamic and changes regularly based on the demand. As demand on the network increases during the rush hours, the rate of HOT rises and at the off peak times the rate drops to be able to keep only a certain number of vehicles on HOT lanes (Gilroy & Pelletier, 2007). Therefore, HOT revenue generation system is categorized under the Variable Tolling system.

HOT revenue generation system has several advantages. It: (i) increases the overall highway operation efficiency by ensuring that HOV lanes are utilized, (ii) provides an option for motorists who can afford paying for faster journeys, and (iii) acts as a win-win system for both people who are using it and others who use conventional lanes as congestion is reduced in the conventional lanes too. The most important advantage of HOT system is that it generates revenues while utilizing existing HOV lanes (Li, 2001). It is important to note that HOT lane operations involve utilization of highly sophisticated technologies for the computation of the dynamic rates, electronic tolling systems, and message boards showing the rate to use the HOT lane at a given time. The technology allows traffic volumes on the HOT lane to be as high as possible, without compromising its non-congested nature (Spock & Liff, 1998). To provide a better explanation of the HOT concept, the following paragraph discusses an implementation example from San Diego.

In San Diego on I-15, Single-Occupant Vehicles are required to pay a toll when they use the HOV lanes. Toll rates are dynamic, varying in 25-cent increments as often as every six minutes to maintain the traffic demand on the HOV lanes at a level so as to ensure free-flow. The annual revenue of this HOT system is $2 million (Federal Highway Administration, 2006). The system consists of two reversible lanes along an eight-mile stretch of I-15. Toll rates range from $0.75 at off-peak periods to $4.00 during the highest peak hour. Tolls are varied based on the demand in the HOV lanes and can jump to as much as $8.00 when there is heavy congestion. I-15 HOT system is intended to generate revenues to be able to fund HOV and transit improvements along the corridor and to maximize the efficiency of both the existing HOV lanes and the conventional lanes (Minnesota Department of Transportation, 2002).

HOT concept has some similarities with the Cordon/Area Pricing discussed in the previous section as (i) it is intended to reduce congestion and (ii) toll rate changes based on the demand which is affected by the time of the day and segment of the road (i.e., two parameters used in the determination of the rates for Cordon/Area Pricing as discussed in the previous section). Nevertheless, HOT concept differs from the Cordon/Area Pricing in one important aspect. HOT is designed to address the issue of underutilized HOV lanes by encouraging the Single-Occupant Vehicles use such HOV lanes upon paying a toll. In this scheme, drivers have the option of using the same segment of the road during anytime without paying a toll. However, in the case of Cordon/Area Pricing, drivers have to pay the toll if they decide to use a certain segment of the road at a certain time. The only way the drivers can avoid paying the toll would be for them to find alternative routes or use the roadway segment when tolls are not in effect (e.g., during non-peak times and the weekends).

Continuous Charging

Continuous Charging is based on the distance travelled (Lewis, 1993) where the road users are charged all the time they use the roadway on which the charges apply. The main scheme utilized for charging a vehicle on a continuous basis for the distance it travels is the Vehicle-Miles-Travelled concept as discussed below.

Vehicles-miles-traveled (VMT): With the US Department of Energy predicting a significant improvement in the fuel efficiency by 2025 and given the fact that different vehicles get very different mileage per the gallon of fuel they use, it may be a better approach to base the revenues needed to construct and maintain highways on the amount of distance travelled on those highways as opposed to the amount of fuel consumed to travel such distance (Forkenbrock & Hanley, 2006). This way the issue of variability in the revenue collected through the fuel tax can be addressed.

With the advancement of Global Positioning System (GPS) and Geographic Information System (GIS) technology, a new system to charge road users began to materialize. This system, called as Vehicle-Miles-Traveled (VMT), can address the issue discussed in the previous paragraph. This is because VMT allows the assessment and collection of charges based on the miles actually traveled by each vehicle as opposed to the fuel consumed. The idea behind VMT is similar to the concept of fuel tax, i.e., the road users are charged all the time they uses their vehicles (Forkenbrock & Hanley, 2006). However, VMT revenue generation system is more appealing than the fuel tax mainly due to the following reasons (Forkenbrock, 2004): (i) increased fuel efficiency resulting in lower revenue collected through the fuel tax per mile traveled and (ii) fuel tax’s prospective inability to be a reliable revenue generation system with the potential of alternative fuel (e.g., hydrogen fuel cell) to be much more widely-used in the future.

While the revenue generation systems included under the Tolling category are mainly used for portions of roadways (typically main arteries and highways), VMT system charges the road users, on a continuous basis, for travelling in all types of roads. VMT system may impose a different rate per mile for different road types, different zones/locations, different time periods, and for different vehicle types (Forkenbrock, 2004; Forkenbrock & Hanley, 2006; Rufolo & Kimpel, 2008).

Monitoring the miles for each vehicle and the rates that apply for each mile travelled by that vehicle (based on the location, time, vehicle type, etc.) is an essential but challenging task for the application of the VMT system. With the advance of technology in radio-frequency based communications, GPS, and onboard computer systems, the implementation of VMT system can be sophisticated. A number of methods are suggested for the implementation of VMT system. One method is based on the interaction between the onboard computer and GPS satellite for the determination of location and mileage information, which is then sent, via radio frequency communication, to a computer that calculates the fee and sends it to the collection points (Porter et al., 2005).

It is important to note that with the utilization of the technology discussed above, privacy becomes a concern for many people. People think that the technology required to make VMT work can easily track all their trips and furthermore generate a travel history. Many people agree to some extent to sacrifice some of their privacy in return for a particular service as in the case of cell phones and credit cards. Nevertheless, they have concerns in sharing this information with the government (Whitty, 2007).

The main implementation example of the VMT system in the US is a pilot study that was run in Oregon in 2006-2007. This study included approximately 250 volunteer drivers. The main objective of this pilot study was to identify the feasibility and applicability of the VMT system as well as its strengths and weaknesses. Furthermore, the pilot study was used to evaluate the perceptions of the drivers. Results from this study revealed that the VMT system is a technologically feasible replacement for the fuel tax (Kim et al., 2008). To evaluate the overall acceptance of the VMT system, participants in pilot study were asked whether they would be willing to use the system to replace the fuel tax. The acceptance level among the participants was 91% (Rufolo & Kimpel, 2008; Whitty, 2007).

Congestion Pricing/Value Pricing Concept

As can be seen in Figure 1, all of the revenue generation systems included under the Direct Charging category can also be considered as Congestion Pricing schemes. Congestion Pricing is used to reduce congestion in the road segments it is implemented on as well as a revenue generation system (Federal Highway Administration, 2008). An alternative name for Congestion Pricing is Value Pricing (DeCorla-Souza, 2008). Congestion Pricing is intended to shift the traffic to other transportation modes or to off-peak periods. By removing a portion of the vehicles from a congested roadway, Congestion Pricing maintains an efficient traffic flow (Federal Highway Administration, 2006). It is important to note that the term “Congestion Pricing” can be used to describe multiple strategies used to reduce congestion and generate revenue at the same time; hence this study’s inclusion of the “Congestion Pricing” term as an overarching theme in the classification developed (as shown in Figure 1).

Public-Private-Partnership (PPP)

It is important to note that the discussion on the revenue generation systems as presented in the preceding sections assumed that the public entity (e.g., transportation agency) is the sole operator of the facilities where any of those systems are implemented. However, another item that should be considered while assessing the alternative revenue generation systems is the case where the highway may be operated by the private sector, resulting in the development of the Public-Private Partnership (PPP) concept. In recent years, the PPP concept has started to become more prominent in the transportation arena. The main idea behind PPP is the collaboration between the public agency and the privately-owned companies to provide infrastructure financing and services. Under the PPP agreement, generally the private investor finances, designs, constructs, maintains, and operates the roads for a specific term; financing its expenditures by collecting tolls/fees from the road users during that term (Gilroy et al., 2007).

Adopting the PPP concept does not preclude the implementation of any of the alternative revenue generation systems discussed earlier. The only difference is that the revenue is generated for the private investor’s (as opposed to the public entity) use to compensate for the expenditures it incurs in financing, designing, constructing, maintaining, and operating the facility. Implementing the PPP concept does not necessarily generate direct revenues for the public entity but instead relieves the public entity of spending any money for the facility. In other words, implementing the PPP system relieves the public entity of its responsibility to generate revenue to address the needs of its highway program. In other cases (two examples of which are provided below while discussing the Chicago Skyway Toll Bridge and Indiana Toll Road) though, the public entity may gather direct revenues by implementing the PPP system, especially in the cases when an existing facility is leased to a private company for it to operate, maintain, and collect tolls. When PPP is used, the motive behind implementing a particular alternative revenue generation system changes as for PPP facilities, a key factor that is considered while determining the toll rate/fee to be collected is the desired or reasonable rate of return on the investment made by the private company (Spock & Liff, 1998).

PPP concept is not recently-developed; it has been used for decades for transportation projects in Europe, Australia, and Latin America. The concept is not new to US either, as a number of states like California, Texas, and Virginia have been utilizing this concept since the 1990s (Gilroy et al., 2007).

PPP is the key solution for infrastructure projects that the state budget cannot afford. It simply provides the public entity with the means to fund its highway programs that could have waited too long to be executed by using the state's budget. In addition to this major advantage, PPPs typically result in innovation as private investors are more likely to examine the alternative approaches that will raise the efficiency of their services for the road users (Gilroy et al., 2007). Furthermore, PPP system often results in the transfer of several risks such as construction risks, delay risks, operation risks, maintenance risks, and revenue risks from the public entity to the private sector (Gilroy et al., 2007; Rye et al., 2008).

Most PPP agreements are unique in nature and a tailored agreement should be developed for each project depending on its conditions, expected revenues, contract period, and forecasts. One of the most unique sections of the PPP agreements relates to the revenue collected from tolls/fees; whether it should all go to the private investor or shared with the public entity. Some agreements set forth how revenues shall be split between parties if the rate of return exceeds a certain limit (Gilroy et al., 2007).

The Acts enacted by the Congress have sections designed to facilitate the utilization of the PPP system. For example ISTEA allowed states to combine funds acquired from the Highway Trust Fund with private funds for developing and constructing roads. Also, TEA-21 had sections that facilitated the use of the PPP system. SAFETEA-LU further facilitated the use of the PPP system by allowing the authorities to seek innovative contracting or innovative financing techniques (National Cooperative Highway Research Program, 2009).

Many states lack specific legislation that authorizes the use of the PPP system. Although the number of states with such legislation has been increasing, as of June 2007 only about half of the states were given the authority to use the PPP system (National Cooperative Highway Research Program, 2009). In majority of those states though, the legislation imposes considerable limitations on the ability of the public entities to use the PPP system. For example, some states (e.g., Alaska, California, Indiana, Missouri, and North Carolina) can use the PPP system for certain types of projects or in limited geographic areas only. Some states (e.g., Maryland and South Carolina) do not allow mixing public and private funds on a highway project. In addition, there are some states that restrict converting any road (whether existing or partially constructed) into a toll road (National Cooperative Highway Research Program, 2009). These legislations restrict the ability of state and local highway entities to enter into PPP agreements with the private sector. Virginia is considered as one of the pioneer states in developing a comprehensive legislation authorizing PPPs. Virginia is planning to address the 15-20% of its transportation needs over the next 20 years by using the PPP system (National Cooperative Highway Research Program, 2009). To provide a better explanation of the PPP system, following paragraph discusses two implementation examples.

Chicago Skyway Toll Bridge is a good example of a PPP arrangement. It was constructed in 1958 to link Chicago's downtown with Indiana highways and has been operated and maintained by the City of Chicago until it was leased to a private consortium to operate and maintain under a PPP arrangement with a value of $1.83 billion in 2005 (National Cooperative Highway Research Program, 2009). The lease term is 99-years and the only income for the consortium is the collected toll. The PPP agreement establishes the maximum amount for the toll rate that the consortium can assess over the lease term (National Cooperative Highway Research Program, 2009). Subsequent to this PPP agreement, the same private consortium signed another contract to operate and maintain Indiana Toll Road for 75 years. The contract value for this agreement was $3.8 billion. The state has used the revenue generated from this PPP agreement to pay for several debts and for future expansion in the state transportation system for 200 projects throughout the state (National Cooperative Highway Research Program, 2009). It is important to note that there have been some concerns with these PPP agreements. These concerns centered on the fact that the life time for a road generally falls between 20-30 years, and thus an agreement for 99 or 75 years should be considered as a transfer of ownership and not a lease (National Cooperative Highway Research Program, 2009).

Conclusions

As the traditional revenue generation system (for the construction and maintenance of the highways), which is mainly based on the collection of federal and state fuel taxes, is becoming less and less reliable (as evidenced by the repeated shortfalls in HTF) due to a number of reasons, transportation agencies are searching alternative systems to generate revenues for their highway programs. These systems are being discussed at different venues as possible long-term solutions to address the increasing needs of the highway program and the funding shortfall. There are newspaper and journal articles about different alternative revenue generation systems, discussing their advantages/disadvantages and applicability. Some of these systems have been around for a long time (nevertheless not utilized frequently) while others are rather newly-developed systems which have been implemented only a few times in pilot projects.

This study synthesized the information on different alternative revenue generation systems and generated a taxonomy of these systems. In investigating these systems, this study made an effort to underline the differences and similarities between them to differentiate one system from another and to identify the common themes between different systems. This study investigated the systems that are used in the US as well as the ones that have not been adopted in the US and/or have not been widely used in the US.

It is important to note that another alternative revenue generation system, parking surcharge, was not included in the paper as the scope of this paper is limited to the main alternative revenue generation systems as underlined earlier. The potential of parking surcharge to generate revenue is insignificant when compared to the main alternative revenue generation systems discussed in the paper.

As shown in this study, transportation agencies have quite a few options for alternative revenue generation systems. Therefore, a transportation agency considering to implement alternative revenue generation systems needs to identify the applicability as well as the pros and cons of each of these systems for its particular scenario. Choosing one system over another one can result in significant changes as far as the amount of generated revenue is concerned. Furthermore, choosing one system over another might have implications on the congestion, level-of-service, customer satisfaction, public acceptance etc. as evidenced in the applications of these systems as discussed in this paper. Additionally, initial costs as well as administrative costs of alternative revenue generation systems need to be considered in making a decision. Finally, technology required for the successful implementation of each system needs to be considered in making a decision. Another issue that needs to be considered by the transportation agency in choosing an alternative revenue generation system is to make sure that legislation allows the utilization of such system, which may not always be the case as evidenced in the PPP legislation of some states.

Most of the alternative revenue generation systems that are discussed in this paper are currently emerging within the US; and are likely to be the standard (as opposed to alternative) revenue generation systems in the future. It is also possible that these systems completely replace the fuel tax in the future. Given this, more research that focuses on the abovementioned considerations (amount of revenue generated, implications on congestion, level-of-service, customer satisfaction, public acceptance, legislation, technology, etc.) needs to be performed in this subject matter.

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