TR NEWS
March–April 2019 NUMBER 320

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The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

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The three Academies work together as the National Academies of Sciences, Engineering, and Medicine to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

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The **Transportation Research Board** is one of seven major programs of the National Academies of Sciences, Engineering, and Medicine. The mission of the Transportation Research Board is to increase the benefits that transportation contributes to society by providing leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation.

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* Membership as of February 2019.

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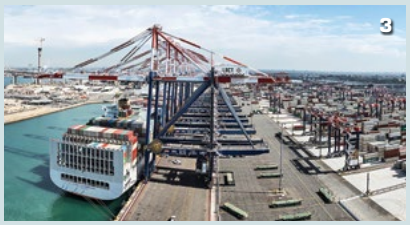

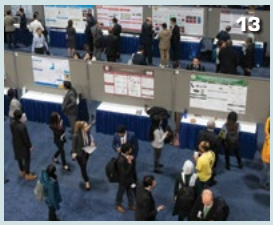

COVER Bridge replacement on the original I-80 San Francisco–Oakland Bay Bridge. An article in this issue of *TR News* examines the research and policy issues surrounding the maintenance and rehabilitation of the Interstate Highway System. (Photo: Frank Schulenburg, Flickr)

Public-Private Partnerships

POLICY, PRACTICE, AND POPULARITY

Photo: Siddharth Patil, Wikimedia

MOHAMMAD S. KHAN

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Above: The new Goethals Bridge between Staten Island, New York, and New Jersey was delivered under a design–build–finance–maintain public–private partnership (P3).

A public–private partnership (P3) is a legal agreement between public and private institutions for some or all aspects of the project life cycle of a public asset, including design, build, finance, operate, and maintain. The traditional project delivery method is design–bid–build, in which public agencies separately contract the design and construction of their assets to private entities and only participate in the preliminary design, bidding, and the contractor oversight. A first step toward greater participation of the private sector, the design–build (DB) method involves a private company designing and building the asset. The ongoing Dulles Metrorail project in Virginia, totaling about $5.68 billion for its two phases combined, is a perfect example of DB.

P3 and Its Evolution

Initiated in 1987, the E-470 highway project in Denver, Colorado, established a basic framework that many future P3 projects followed. Project E-470 was not a P3 in true sense, but had all the characteristics of a P3 project. The state legislature created a new public entity, the E-470 Public Highway Authority, to design, build, finance, operate, and maintain the 47-mile segment of the highway. The initial segment of the project opened in June 1991 and the project was completed in January 2003. Toll revenues were the primary source of funding for the project. In a typical P3 project, a private entity would take the place of the E-470 Public Highway Authority.

In the United States, P3s began to take hold in the early 1990s. Between 1993 and 2017, 32 transportation P3 projects were completed, with a total cost of about $45 billion. This is a very small share of the nation's overall spending on transportation projects—according to a Congressional Research Service Report, P3s account for approximately 2% of public infrastructure (*1*).

Between 1985 and 2009, $996 billion of transportation P3 projects were planned and funded worldwide. Of these, 12.1% were in the United States, 2.8% were in Canada, 15.3% were in Latin America, 48% were in Europe, 2.3% were in Africa and the Middle East, and 19.5% were in Asia and the Far East (*2*, see Figure 1, below). These data show that P3s are more accepted and popular in Europe than in other regions of the world.

The Gordie Howe Bridge, linking Detroit, Michigan, in the United States and Windsor, Ontario, in Canada, is a recent major international P3 project. The selection of the project firm was announced in July 2018 and the P3 agreement signed in September. The $5.7 billion fixed-price contract includes the DB and operation, maintenance, and rehabilitation phases, and the project is scheduled to be completed by the end of 2024.

Legislative Authority

For public agencies to enter into a long-term legal agreement with a private entity, which typically lasts anywhere from 30 to 99 years, the agencies need to have legislative authority. Currently, 33 states, the District of Columbia, and Puerto Rico have legislative authority to enter into a P3 agreement.

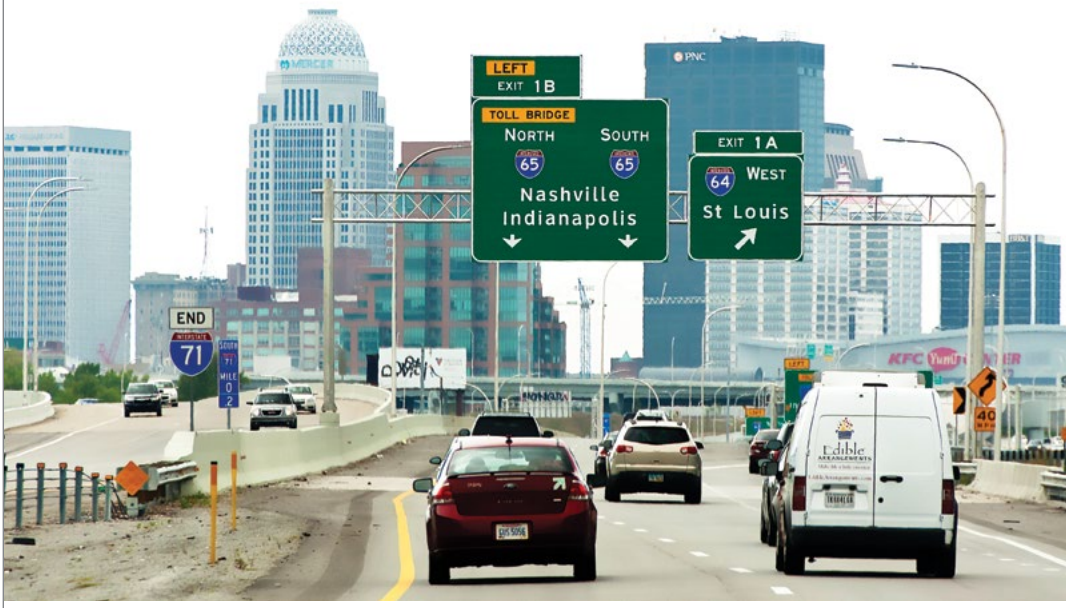


Photo: Sixflashphotos, Wikimedia

Kentucky and some other states allow tolls associated with P3 projects to be set and collected for only as long as revenue bonds are outstanding.

Though most states' legislations have enabled P3s, these laws vary widely in scope and limitation from state to state. For example, 25 states authorize all levels of government within the state to enter into a P3 agreement, and all types of infrastructure can be part of a P3 agreement. In other states, only the state is authorized to enter into a P3 agreement or a P3 can only be used for transportation projects. Some states have authorized DB projects, some have authorized P3s for existing and new facilities, some allow high-occupancy toll (HOT) lanes for congestion pricing, and some even allow for the conversion of existing roads to toll roads. On the other hand, some states have placed limits on the length of P3 agreements and some do not allow noncompete clauses in P3 agreements—that is, states can initiate projects in the vicinity of a P3, often in competition with the P3 project. Also, some states have instated annual caps on the number or cumulative dollar value of P3 projects (*3*).

Tolling of highways in general—and P3 projects in particular—has been a contentious issue. On transportation P3 projects, tolling generally is the primary source of funding; 29 states have addressed tolling and rate-setting authority via legislation. Some states specifically direct how and when the toll rates can be changed and in a few states, tolls must be removed after the initial construction debt is repaid. For example, Kentucky statute §54-3-104(c) allows tolls to be set and collected only as long as toll revenue bonds are outstanding (*3*).

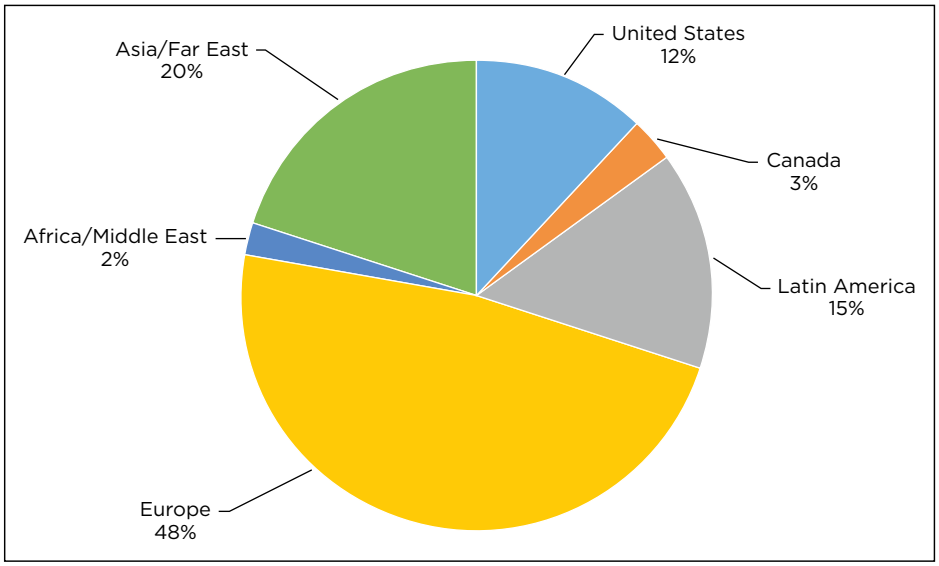


FIGURE 1 Percentages per region of the $996 billion total in transportation projects between 1985 and 2009 that were P3 projects.

Funding and Financing

In a P3 project, the public funds the project and public and private entities jointly finance the project. If public funds are sufficient to start, sustain, and complete a project, there probably is no need for a P3. But because of the challenges of limited state and local government budgets, the design, construction, operation, and maintenance of major transportation assets has become difficult. In P3 business models, a private entity shares project financing with a public agency in return for performing some or all components of the project and then sharing the revenues generated.

Collecting revenues (that is, funding), traditionally the function of public entities, can be delegated to the private entity in a P3 agreement. P3 projects generally are classified by how revenues are collected and how the private entity realizes its return on investment. The private entity can directly collect revenues (e.g., tolls and fares)—termed "revenue risk"—or the public agency can pay the private entity based on milestones and performance—termed "availability payment." In a revenue risk project, the private entity assumes a risk in that revenues can be higher or lower than forecast.

The Capital Beltway HOT Lanes project on I-495 in Fairfax County, Virginia, which was completed in November 2012, is an example of P3 funding and financing (see photo below). The funding source for the HOT lanes is tolls, which are collected by a private entity for a public asset. The shares of public and private entities in financing the $2.068 billion project were as follows: a 28.5% loan from the U.S. Department of Transportation (DOT) to the private entity under the Transportation Infrastructure Financing and Innovation (TIFIA) program; 28.5% in private activity bonds (PABs); a 24% contribution from the Commonwealth of Virginia; a 17% contribution from the private entity; and 2% from interest earnings.

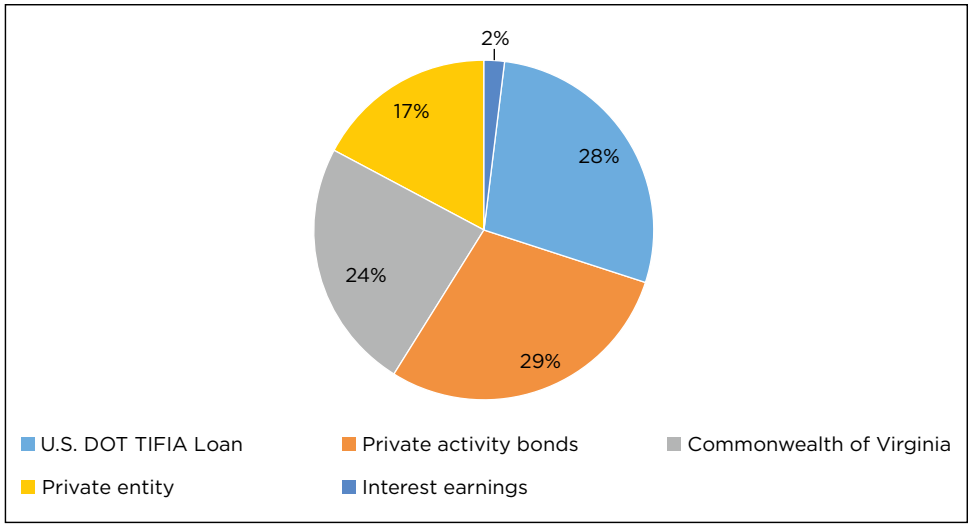
The financing share of the public and private entities is determined on a project-by-project basis. For example, on the subsequent $922.6 million I-95 HOT Lanes project in Virginia, completed in December 2014 and involving the same public and private entities, the corresponding financing share percentages were as follows: 33% from the U.S. DOT TIFIA program, 27% in PABs, 9% from Virginia, 30% from private equity, and 1% from interest earnings. The significant increase in private investment and decrease in public investment reflects the private partner's comfort with the success of the I-495 project (Figure 2, page 33).

U.S. DOT TIFIA LOANS

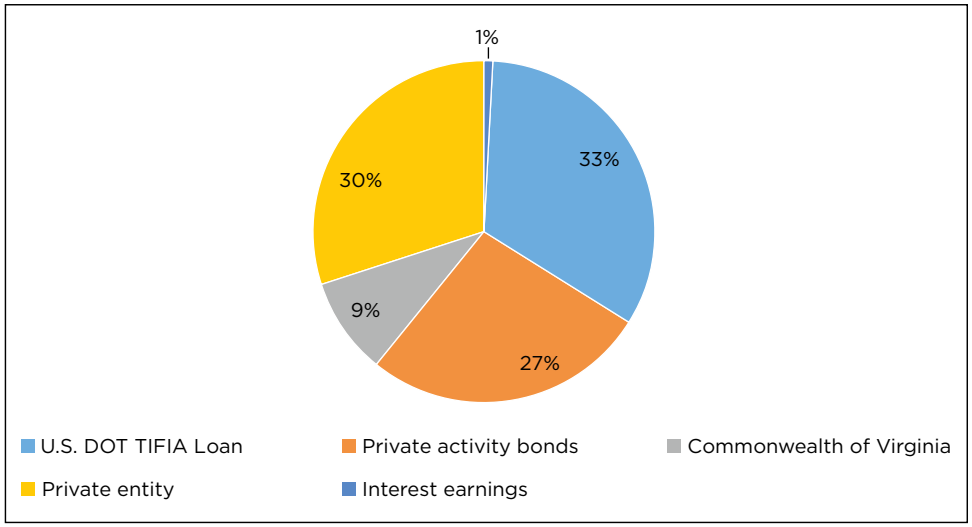
The borrower under the TIFIA program can be a state or local government, public authority, P3, or any other legal entity undertaking the project and authorized by the U.S. Transportation Secretary. The projects eligible for a TIFIA loan generally are at least $50 million, with a lower cost threshold of between $10 and $15 million for projects involving intelligent transportation systems, transit-oriented development, and rural or local infrastructure. Among other requirements, the borrower must establish their creditworthiness by achieving an investment-grade rating from at least one credible credit rating agency. On large P3 projects, the TIFIA loan is very attractive to a private entity because of low interest rates that otherwise would not

Photo: Virginia DOT

The Capital Beltway high-occupancy toll lanes project in Virginia. Funding for the project was provided in small part by public agencies and in larger measure by private entities, who collect tolls from noncarpooling drivers.



(a)



(b)

FIGURE 2 Financing share of project by source for (*a*) the $2.068 billion Capital Beltway HOT Lanes project and (*b*) the $922.6 million I-95 HOT Lanes project.

be available to them. TIFIA loan interest rates are fixed and are the same as the U.S. Treasury borrowing rate, with a term generally of 35 years from the date of substantial completion of the project. TIFIA loans can finance up to 49% of the project cost.

PRIVATE ACTIVITY BONDS

PABs are similar to municipal bonds but are administered by U.S. DOT, as authorized by Congress (*4*). Currently, the U.S. Transportation Secretary has the authority to issue $15 billion in PABs; as of November 27, 2018, approximately $11 billion in PABs have been issued or allocated in 28 transportation projects nationwide. The projects eligible to be financed via PABs include aviation, marine, rail, highway, and freight transfer facilities. PABs are attractive to regular citizens because they are tax exempt; the interest earned on these bonds generally is exempt from federal, state, and local taxes.

STATE CONTRIBUTIONS

State governments can make their contributions to P3 projects from federal highway funds apportioned for their state, state infrastructure banks (SIBs), or any other authorized sources. Thirty-two states and Puerto Rico have federally authorized SIBs (*5*). These SIBs can be capitalized on by using some of the state's share of federal surface transportation funds. Some states, such as California, Florida, Georgia, Kansas, Ohio, and Virginia, have established SIBs without any federal affiliation or assistance.

Legal Implications

P3s are long-term, complex legal agreements between a public entity and private entity; during the term of the agreement, lots of things can happen on either side that may not be conducive to an agreement already in place. Unresolved legal and regulatory issues and future laws and regulations can be problematic. The $1.4 billion P3 agreement for US-460 in Virginia is a recent example. The agreement was signed in December 2012, but the state

Photo: Dom Blevins, Wikimedia

Private activity bonds (PABs) funded Florida's Brightline expansion into Orlando. PABs are designed for private infrastructure that provides a public benefit.

suspended the work in early 2014 and canceled the agreement in early 2015. The main reason cited for the failed P3 agreement was that the project would not have been able to receive the environmental permits required for large swaths of wetlands along the 55-mile route. By the time the agreement was canceled, the state had already paid the private entity more than $250 million—including $125 million generated from bonds.

Another serious concern is the potential bankruptcy of a private entity during the lifetime of a P3 agreement. The private entity usually is a consortium of several different private organizations, including engineers, builders, and financial institutions, and the failure of one of these companies can bring the entire private partner down. A bankruptcy during the design and construction phase of the project—when most of the cost is incurred and few revenues are made—can be particularly damaging to a public partner.

TIFIA loans generally are subordinate debt; that is, payable after senior debt obligations are met. According to the TIFIA program's safeguard clause, however, a TIFIA loan becomes a senior debt in the case of bankruptcy. For example, for the Elizabeth River Tunnels P3 project in the Norfolk–Portsmouth area of Virginia, PABs comprise the project's senior debt. Loans from banks and other financial institutions on P3 projects generally are treated as senior debt as well. This hierarchy of senior and subordinate debts refers to their order of payment in cases both of healthy financing and of a defaulted project.

> Though most states' legislations have enabled P3s, these laws vary widely in scope and limitation from state to state.

A bankruptcy occurred in the $3.8 billion, 75-year P3 agreement between the Indiana Finance Authority (IFA) and a private entity for the operation and maintenance of the Indiana Toll Road (see photo below). The agreement was signed in April 2006 and the private entity filed bankruptcy in 2014. IFA entered into a new $5.7 billion, 66-year lease with another private entity in 2015. Aside from some uncertainty for a year or so, this bankruptcy was not too damaging to the state because it involved the operation and maintenance of an existing facility during a revenue-generating period.

Photo: Haydn Blackey, Flickr

When the private company operating the Indiana Toll Road declared bankruptcy, a new agreement was made with a different entity for the remainder of the operational and maintenance contract.

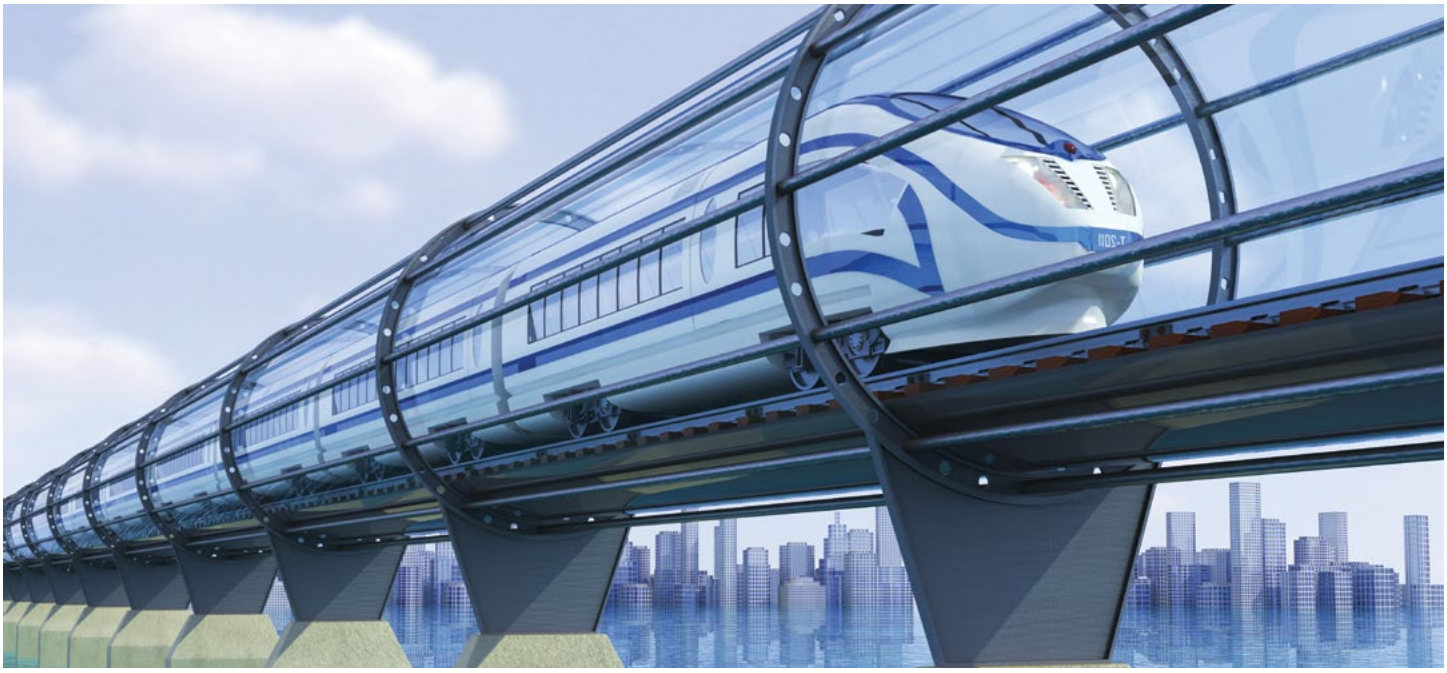
Innovative Solutions

Because of their nonprescriptive, performance-based, long-term nature, P3 projects provide an opportunity for innovative solutions—likely more than any other venue. The private entity is free to adopt and implement almost any innovation in design, construction, operation, and maintenance, as long as the performance standards established by the public agency in the agreement are met.

BUILDING INFORMATION MODELING

A technological advancement particularly well-suited for P3 projects is building information modeling (BIM). This technology has gained popularity in the building industry in the past two decades, but its acceptance in the transportation industry is still lacking. In BIM, the entire life cycle of a P3 project—including planning, surveying, design, construction, operation, and maintenance—can be created as a 3-D computer model that can be shared and modified digitally by participating team members. This model is improved and strengthened as more and more data become available and it essentially becomes a digital replica of the physical infrastructure, allowing people to visualize the infrastructure. Changes in project conditions can easily be entered and their effect on related parts of the project immediately noticed. Simulations can test different design options virtually under different loading configurations.

Cost information is part of BIM, facilitating timely procurements. BIM also can incorporate information about a project's surroundings, including underground wa-



ter mains and utilities, and thus any conflicts with surroundings can be resolved easily. The detailed models of transportation infrastructure created through BIM also can assist connected and automated vehicle technology, which relies on accurate data and information.

OTHER TECHNOLOGIES

P3s present opportunities for adoption and implementation of other technologies, such as advanced sensors for monitoring and asset management and even futuristic design and construction technologies like 3-D printing (*6*–*7*). The significance and magnitude of transportation P3 projects is such that they generally are part of the nation's critical infrastructure. A transportation infrastructure element embedded with monitoring sensors can add to its safety and security. A variety of sensors are at different stages of development, including piezoelectric sensors, fiber-optic sensors, and eddy current sensors.

CHICAGO HYPERLOOP

In June 2018, a P3 agreement was announced to design, build, finance, operate, and maintain a high-speed transportation system between Chicago's downtown area and O'Hare International Airport. Using hyperloop technology, high-powered automated vehicles in a tunnel will transport passengers between these two congested locations in about 12 minutes at a speed of 150 mph (see illustration above). The trip usually takes at least 40 minutes by transit or car.

A unique feature of this agreement is that no public financing will be used—the entire $1 billion project cost will be financed by a private entity. In this hyperloop transportation system, a magnetic levitation environment, often a vacuum, allows automated vehicles to accelerate from zero to 192 mph and decelerate back to a complete stop in less than 0.31 mi (*8*). Considering the relatively short distance on the Chicago project, no vacuum will be used.

The significance and magnitude of transportation P3 projects is such that they generally are part of the nation's critical infrastructure.

Moving Forward with P3

Although it has been 30 years since P3 projects first emerged in the United States, and many projects have been completed using this business model, the acceptance, popularity, and market share of P3s are still low. About 30% of states still do not have P3-enabling legislation, and tolling—the primary source of funding for transportation P3 projects—still is a contentious issue and lacks public support. A common public perception is that the nation's public assets are being taken over by large private institutions, both of domestic and foreign origins, primarily for the sake of profit-making and without contributing much to local communities.

To some extent, it is true that private entities are assuming control of public assets for as long as 75 or 99 years without an equitable investment in these assets. With a few exceptions, the share of private equity on transportation P3 projects is much less than 50%. Public sources

People, Planet, and Profit

A common perception of public–private partnerships (P3s) is that they do not add to the goal of sustainability. For P3s to be more acceptable and popular, it is important that they align with another P3: people, planet, and profit, also referred to as the "triple bottom line." These two P3s have one common element—profit—but people and planet are not as obvious in P3s. Transportation projects established with a goal of achieving both of these P3s can be much more popular.

The $2.9 billion I-4 Ultimate P3 Improvement project in Florida, expected to be completed by 2020, is an example of a project in which sustainability benefits are well highlighted. This project received Envision Platinum recognition from the Institute for Sustainable Infrastructure on the basis of its positive contributions to social, economic, and environmental impacts on a community.

Some of the attributes of a sustainable P3 project include

- Profitable and thriving businesses of all types and sizes;
- High employment opportunities and low unemployment rates;
- Training and workforce development opportunities;
- Higher income per capita;
- Investment and reinvestment of businesses in communities;
- Safe and secure communities;
- Better accessibility to educational, health, shopping, sports, and recreational facilities;
- Affordable cost of living;
- Lower commute time;
- Easy accessibility to other modes of transportation, such as transit, rail, airport, and ports;
- Safe drinking water and air;
- Control of environmental contamination of land, air, and water;
- Protection of wetlands, wildlife, and natural habitats;
- Recycling of construction materials from existing facilities;
- Reduction of carbon and greenhouse gas emissions; and
- Long service life—100 years or more—for transportation facilities.

of financing, like TIFIA loans and tax exempt PABs, all are subsidized to varying degrees, at public cost. Furthermore, in cases of failed P3s and bankruptcies, the responsibilities of the asset fall back on the shoulders of public agencies. Thus, in order to be a true P3, the share of the private equity should be at least 50% and as much as 100%. At this level of maturity of transportation P3 projects, the following share of investment is reasonable: 20% TIFIA loans, 20% PABs, 10% state contributions, and 50% private equity.

To encourage participation from smaller private entities, P3s of less than $1 billion in present value should be considered more favorably. Megaprojects may be divided into parts or phases. Also, limiting concession periods to 50 years would allow public agencies to better manage future unknowns and opportunities.

Only $4 billion is left of the $15 billion authorized limit for PABs; it would be wise to consider increasing this ceiling to $30 billion. Also worthy of consideration is increasing the availability of TIFIA loans—from 2016 to 2020, the average is about $285 million per year—to at least $500 million per year.

For states that are reluctant to facilitate the wider use of P3s, adopting policies friendly to DB projects is a step in the direction of P3s. Design–build projects are a form of P3 that preserve more control and risk for the public agency. Innovative and sustainable solutions should be the cornerstone of P3 projects, embedded in the process at the time these projects are created. Finally, communities should be educated about P3s.

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