RISK FRAMEWORK FOR
PUBLIC PRIVATE PARTNERSHIPS IN
HIGHWAY CONSTRUCTION

by

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ABSTRACT

Recent Public Private Partnerships (P3) in the United States represents a significant advancement in the level of participation of the private sector in the provision of road and highway assets. A number of states and local governments consider P3 as a mechanism to streamline project delivery, transfer risk, reduce costs and raise additional transportation revenues. P3 broaden the private sector’s participation beyond the design and construction phases to include the assumption of responsibility and risks for the financing, operations, and maintenance of project.

In this paper, the author introduces a framework that identifies and organizes the broad range of risks associated with P3 arrangements for highway project delivery. The “PEST” framework organizes risks into four categories: Political, Economic, Socio-Cultural and Technical which could help P3 projects in devising risk management strategies. P3 projects could benefit by these categorization in identifying, allocating, managing and thus minimizing overall project risks. The framework was developed by considering the risks associated with major P3 highway projects in the United States. Project documentation, case studies, and literature related to P3 highway projects (completed/on-going) were used to validate the framework. The categorization of the risk factors can help practitioners identify the parties involved (public or private) that assume the most risk based on different phases of highway construction and the type of risk involved within it. The PEST framework illustrates the distribution of risk by project types, phases of construction and risk dependencies. It gives greater ability to monitor and control common type of identified and classified risks. The PEST framework can encourage proactive thinking and help in clear visualization of risks involved in P3 projects enabling better decision making. Some analytical tools are discussed that could assist in risk analysis. The PEST framework is demonstrated within the influence diagram and state diagram. Representation of PEST with these diagrams could be useful for practitioners and decision makers to visualize in which phase most of the risk lies, its dependencies and the outcome of these risks. This could also help practitioners in planning risk mitigation and management strategies based on categories identified in this paper.

KEY WORDS

Public Private Partnership, highway, construction, risk.

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INTRODUCTION

In recent years, there has been a growing interest in P3 in transportation sectors. The primary reasons that public agencies are entering into P3 include the escalating costs of highway system preservation, the ever increasing need to improve the performance of transportation infrastructure, the slowing growth of fuel tax revenues and other traditional highway revenue sources, and state transportation agencies downsizing (FHWA 2009).

In traditional contracting, the state transportation agencies choose and hire private contractors for projects based on the lowest bid. This approach can save initial construction costs, but may result in higher life cycle cost as well as less incentive for innovation. The traditional process might also result in longer lead times between conception and completion of projects. Therefore, many states are increasingly experimenting with new contracting methods including P3. Twenty-one states have passed legislation enabling public-private partnerships in highway transportation (Mazurek 2008). The primary benefits the public sector seeks to achieve through P3 are cost savings, shortened project delivery time, and allocation of risk to the parties that are best able to manage it. P3 projects can also be used to cut the cost incurred for the maintenance of roads, often one-half of a state’s total highway budget (USDOT 2008).

The federal government’s primary role in roads and highways in the United States is to provide funding. Roads and highways are generally owned and operated at the state or local level. For this reason, express authorization to engage in a P3 for a transportation project must be provided by the state and/or local legislative authority.

The federal government’s role in P3 has primarily focused on providing federal credit assistance to help attract private sector investment in road and highway projects. The TIFIA (TIFIA is the Transportation Infrastructure Finance and Innovation Act of 1998) program provides loans, loan guarantees, and lines of credit for eligible transportation projects of national or regional significance. In 2005, the Federal tax code was amended to permit the issuance of tax exempt Private Activity Bonds (PABs) to develop, design, finance, construct, operate and maintain highway and freight transfer facilities. A state or local government entity can issue the PABs, but the private developer is the borrower and therefore responsible for repayment. State Infrastructure Banks (SIBs) leverage federal and state resources by lending rather than granting federal-aid funds for non-federal public and private investment in infrastructure projects (Adams 2009).

Identifying the risks in advance and allocating these risks to the party who can best manage can reduce the overall project risk. Risk categories are specific way to group risks that provide a common structured and systematic approach in identifying and impacting similar aspects in the project. The goal of this paper is to develop a risk framework (PEST) by categorizing P3 risk factors into four groups: Political, Economic, Socio-Cultural and Technical. PEST framework of risk factors could play an important role for developing risk management strategies. The PEST framework of risk factors is useful for understanding the risks involved in different categories and responsible parties. The PEST framework enables a greater management focus, stimulates, and helps in increasing the opportunity of identifying a wider range of risks. Categorizing risks improves the effectiveness & quality of the risk identification and analysis processes. Also by grouping risks by common or similar root causes can lead to developing effective risk responses. The PEST framework illustrates the distribution of risk by project types, phases of construction and risk dependencies. It gives greater ability to monitor and control common type identified and classified risks. The PEST framework can encourage proactive thinking and help in clear risks visualization of the risks involved in P3 projects to enable better decision making.

The Political risk (P) includes risks arising from government action which includes political stability, employment laws and competition regulations. The Economic risk includes the changes in
interest rates and monetary policies, government spending, taxation, exchange rates and inflation rates. The Socio-cultural risk (S) includes risks of attaining the public support, transparency throughout the project. Technical risk (T) is mostly during the operational phase of the project and includes project management issues, design related risks and issues of technological advancement in equipment, application, and materials.

This research also further categorizes risk factors based on risk occurrence during different phases of construction (planning, pre-construction, construction, operation and maintenance). Risk categories can also be grouped according to the types of project (green field or brown field), and also by risk dependencies (independent, contingent or mutually exclusive). The case studies, based on Chicago Skyway and Port of Miami Tunnel, are used in this paper to show the implementation of the PEST framework.

Project documentation, case studies, and literature related to P3 highway projects (completed/ongoing) were used to identify and validate the framework. This research consists of a theoretical case-based research approach. Many case studies and literature have been reviewed for collecting the risk factors involved with P3 highway projects. To collect and categorize the risk factors, projects delivered in diverse countries such as the US, UK, India and Indonesia, were studied. This case study, however, focuses on risk factors which apply to the P3 highway projects in the US.

PUBLIC PRIVATE PARTNERSHIPS (P3)

The US Department of Transportation defines P3 as “contractual arrangements between public and private sector entities pursuant to which the private sector is involved in multiple elements of public infrastructure projects. Unlike conventional methods of contracting for a project, in which discrete functions are divided and procured through separate solicitations, P3 contemplate a single private entity being responsible and financially liable for performing all or a significant number of functions in connection with a project” (USDOT 2008).

In practice, almost all transportation projects involve some kind of partnership with the private sector. The project delivery methods range from Design-Bid-Build (DBB, the traditional method) to Design-Build (DB) to Construction Manager/General Contractor (CM/GC) to Design-Build-Operate (DBO) to Design-Build-Finance-Operate (DBFO) to Design-Build-Finance-Maintain (DBFM). For example, in CM/GC, the public party holds the contract for both the design consultant and the contractor; hence most of the risks are borne by the public party for constructing the project within the budget and schedule. In Design-Build-Finance-Maintain projects, the private party assumes the responsibility for financing as well as building the project. DBFO projects may hold the private party responsible for designing, building, financing the project, and operating and maintaining the facility (often for 30 years or more) (Murphy 2008). The figure below shows that DBMFO has the most responsibility assigned to the private sector. Figure 1 defines P3 in this paper, where mostly private sector is responsible for financing, designing, building and operating and maintaining the facility.

![Figure 1 Range of Project delivery mechanisms](image-url)
In the United States, some of the projects that implemented some form of P3 are:

- Chicago Skyway Long-term Lease - Chicago, Illinois
- South Bay Expressway (State Road 125) – San Diego County, California
- Trans-Texas Corridor (TTC) – 35 Toll Road Program – East Central Texas
- Port of Miami Tunnel – Miami, Florida
- Atlantic Station 17th Street Bridge – Atlanta, Georgia
- Route 28 Phase II Expansion – Fairfax and Loudon Counties, Virginia

There are different challenges between two types of P3 projects, one with the long-term leasing of existing facilities and with new construction and long-term operation of new facilities (Transportation for Tomorrow 2007). Private investments in existing infrastructure through long-term leases, often called “brownfield” projects, involve a private operator assuming control of the existing facility including responsibilities for maintenance and operation and collection of toll revenues for a fixed period of time in exchange for a concession fee provided to the public sector. In the construction of new infrastructure, commonly called “greenfield projects,” the private sector provides financing for construction of the facility and then assumes responsibility for all operations and maintenance for a specified amount of time. In both cases, the concessionaire assumes the risk that revenues will be sufficient to repay initial equity and debt, long-term operating and maintenance costs, and costs for renewal and rehabilitation, in addition to returning a reasonable profit. For greenfield projects the concessionaire assumes the risk of uncertain traffic demand. Brownfield projects have less risk because the traffic history is known, but usually involve an upfront payment from the concessionaire. Both brownfield and greenfield P3 may have provisions for revenue sharing during the concession period. While most of the P3 in the United States have been for toll roads, some P3 concessions are for toll-free facilities. When tolls are charged, there is usually a provision to protect the public from monopolistic toll charges.
RISK CATEGORIES

Identifying and sharing risk in P3 projects are essential for the success of the partnership and project. Risk is something that creates or suggests a hazard, which might include delays in construction schedule and cost overruns. A significant feature of the P3 approach is that while the allocation of risk is to the partner (private or public) most able to manage that risk, however no party is immune from risks entirely.

Li, Akintoye, and Hardcastle (2001) proposed a three-level risk factor classification and checklist for P3 projects by the three tiers in their classification concern ‘macro’ (ecological, political, economic, social, natural environment, etc) risks, ‘meso’ (project-engineering) risks and ‘soft’ (micro level) risks. To categorize risks associated with P3 highway projects, the author categorized the risks identified by the work of Li et al. (2001) and Iyer and Sagheer (2010) to develop the PEST framework, encompassing Political, Economic, Socio-Cultural and Technical risks. The PEST framework further expands into categorizing the different risk factors identified according to the responsible parties at the different phases. The framework also accounts for phases of construction: planning, pre-construction, construction or maintenance and operation; and project type: green field or brown field. The relationship of dependencies of risks will also help the practitioner to identify, allocate and better manage the risks by developing risk management/mitigation strategies. For example, Table 1 shows in which phase of construction the risk lies for the two types of projects- brownfield and greenfield. The shaded area represents phases that are not applicable to a brownfield project.

Table 1 Risk in different project phases according to project types

<table>
<thead>
<tr>
<th>Type</th>
<th>Planning</th>
<th>Financing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Project Planning</td>
<td>Financial Feasibility</td>
</tr>
<tr>
<td>Brownfield</td>
<td>✔️</td>
<td>✔️</td>
</tr>
<tr>
<td>Greenfield</td>
<td>✔️</td>
<td>✔️</td>
</tr>
</tbody>
</table>

1 Design, 2 Build, 3 Maintain, 4 Operate
Most of risks identified can be assigned to at least one of the P, E, S, T categories as defined in the PEST framework.

**Political Risks**

The political risk involves political issues associated with industry and governing laws and comprises of risks arising from government action. Political risk is more significant during the development stage of a project through to contract signature. For this paper, Political risk has been defined as the risk resulting from the adverse interference of government on the project operations or as a result of political decision that could result in reduced returns, major losses or managerial control. It also includes political stability, employment laws and competition regulations.

- **Direct political risk:** These risks may occur due to changes in law, compulsory acquisition or expropriation of project assets or concessionaire rights, revocation or refusal to grant licenses, permits, consents, or approvals (KCI Technologies 2005). The outcomes of these types of risk can either be public outrage or public acceptance.

- **Political decision making:** Political decision makers can influence the success of a project. In both Chicago Skyway and parking project, and to a lesser extent the I-80 project, the concessions were given because the political decision makers estimated they could not raise the rates. A major backlash happened when the vendors raised those rates. The risk is in part in the backlash and in part in understanding the motivation for the concession.

- **Right-of-way risk:** Most transportation projects require large stretches of land. Right of way risks include unanticipated acquisition costs, appraisals, relocation delays, and condemnation proceedings, delays in the survey and notification process and political patronage for encroachments, litigation and court proceedings. The outcome will be either a negotiated budget or increased budget realignment.

- **Competing facilities risk:** These risks occur due to competition in the same areas; or when governments view the leasing of existing transportation assets as a potential income source. There may be public benefits if the transactions are properly structured. But if structured poorly, it can give substantial monopoly power to the concessionaires at the cost to the users of the system. For example a toll concession may compete with a non-toll road.

- **Regulatory risk:** These risks are related to obtaining approvals and complying with permits, utilities and environmental rules.

- **Protectionism:** Protectionism is the economic policy of restraining trade between nations, through methods such as tariffs on imported goods, restrictive quotas, a variety of other government regulations designed to discourage imports, and to prevent foreign take-over of native markets and companies. The result of this could be either unfair bidding or competitiveness.

- **Legislation change:** These risks are associated with changes in rules and regulations and might lead to either acceptance or outrage from the public.
Economic Risks

Economic risk (E) comprises of those risks resulting in a drop in revenues or project financiers suddenly pulling out. Economic risks are due to the uncertainty of costs and revenue generation. The related risks are as follows:

- **Pre-investment risks:** This risk is associated with the considerable investment in project feasibility study, bid preparation and availability of project funding. This risk can either lead to winning the contract or losing it. The project can also be delayed due to lack of funding and time spent on getting the loan.

- **Tolls Revenues:** Tolls revenue risk is that the toll revenues may not adequately cover maintenance and operations costs or provide the expected return on investments. In P3 projects, it would be expected that the private party could request cash compensation from the government/public party for a deficiency in income from fares or tolls, request authority to increase tolls or fares, or extend the concession period. It is necessary to identify its risks clearly with respect to cash flow or its returns, as they may be affected by an extended concession period. The anticipated toll revenue could be over or underestimated.

- **Financial risks:** These risks arise due to general price increases or other economic factors such as inflation and interest rates. Other financial risks are related to sudden changes in exchange rates, taxes and import duties, cost of indemnities and insurance and increased commodity prices due to large cross-border capital flows. This risk can also be due to the bond issuer not repaying principal and interest on time (Iyer and Sagheer 2010). The outcomes can be a loss in profits.

- **Cost overrun risks:** These risks arise due to failure to finish the project within the budgeted cost. The reason for this may vary from an increase in general price level to economic factors such as inflation, interest rates etc. These risks affect the concession company/private party directly. The action that could be taken is to claim liquidated damages from the contractor.

Socio-Cultural Risks

Socio-cultural risk (S) is risk that can have direct or indirect effect on the society or the user of the facility. It also includes the relationship risk between the parties involved in the contract, moral hazard, and the equal participation of different groups of the society.

- **Public opinion:** Transparency refers to letting the public and other parties involved have a clear perspective of the project. Public opinion against P3 in Indiana created an impression of distrust of foreign companies and a fear of tolls being overly expensive. The government must ensure that the public interest is incorporated. The outcomes of this risk may either be public outrage or public acceptance.

- **Environmental risks:** This type of risk can occur due to potential adverse effects on human health or the environment like noise, air quality. These are risks are related to occurrence of environmental incidents during implementation of the project.

- **Moral Hazard:** Moral hazard is the risk that a party in a contract has not entered into the contract in good faith, and has provided misleading information about its assets, liabilities or credit capacity. This party also has an incentive to take unusual risks in order to get more profit.
**Partnering risks:** In a consortium approach, team spirit and mutual trust are very important. There can be project risks due to lack in performance of an individual and/or organizations contributing in the project. This type of risk can lead to litigations.

**Environmental Justice:** Under current policy, projects can be delayed or cancelled if disproportionate adverse impacts to particular classes are associated with the project. Projects require appropriate planning to reduce the impact on minority or economically disadvantaged populations.

**Technical Risks**

Technical risk (T) includes risk related to differing site conditions, traffic control, public access, weather issues, etc. Technical risks arise from lack of new technology, defect in design, manufacturing and engineering. The technical risks during construction may include:

- **Project management risks:** These risks include cost and time overruns due to poor contract and schedule management, contractual disputes, delays of tendering and selection procedures, or poor communication between project parties. It also includes the schedule risks, which arise due to failure to finish the project within the scheduled time. This can include the cost of carrying the debt during delays in project completion. In P3 projects in highway construction, there may arise conflict between private and public parties which may cause changes in schedules resulting in delay in the project duration. The outcomes could be less or more profit margin, public acceptance or dissatisfaction.

- **Construction risks:** The construction risks consist of various individual risk factors that adversely affect the construction of a project within the schedule and budget projected and at the standards specified for the facility. This type of risk includes cost overruns, time and quality, cost and scope of identified work.

- **Design and latent defect risks:** These risks can arise due to defective design, unclear specifications and plans, errors and omissions in design, or inaccurate geological and geotechnical exploration. Most of the time, it is the design contractor who is responsible for the design of the project. The outcomes can either be poor quality of product or rework which will greatly impact the timeline of the project.

- **Technology risks:** These are risks related to selecting technologies for highway operations. Technology standards change rapidly; hence equipment may become obsolete or incompatible quickly. The outcomes could effect in the efficiency of the product.

- **Force majeure:** These unforeseen risks, also termed as “Acts of God”, are the epidemics, natural disasters, earthquakes, floods, etc or those due to unpredictable events such as fire, storm, terrorism, flood, etc. This can lead to project schedule delay and additional costs.

- **Physical risks:** These risks are those encountered by any other project. Physical risks are those that can damage the quality of the road/highway, damage to the construction equipment, labor, etc. which are equally critical during construction and operation phases of the highway projects (Iyer and Sagheer 2010).
The risks can be properly allocated by preplanning and sharing resources between the parties involved. The public agencies primarily assumes risk during the project scope and definition and are primarily responsible for activities associated with environmental clearance, right of way acquisition, conceptual engineering, forecasting demand and revenue, financial feasibility analysis, agency permitting, political and stakeholder commitment and any necessary enabling legislation.

The survey on risk allocation conducted by Li et al. (2005) showed that the political risks should be retained by the public partner and most of the project-specific risks should be allocated to the private partner. The risk factors such as force majeure and changes in law should be shared by both parties. The risk allocation strongly depends on specific project circumstances like the level of the public support, project approval and permit, the contract variation and the lack of experience with P3. A standard model of risk allocation is not possible, because projects differ widely.

Table 2 shows the risk factors categorized in the PEST framework. This table also shows which party (public, private or both) bears the risks. For example, direct political risk is categorized under Political (P) risks which the public sector is mostly responsible for. Most of the technical risks related to project management lie in the contractor’s part, hence the private party bears these technical risks. This may vary according to project type and size. For example, in the project of Port of Miami Tunnel, the construction risk was shared due the complexity and geotechnical risk of the project. Both the public and private parties bear the risks categorized under the socio-cultural, for example risk factors such as moral hazard, environmental and environmental justice. This will allow the different parties to know where most of the risks lie, and which party the risks are associated with.

<table>
<thead>
<tr>
<th>PEST</th>
<th>Risk</th>
<th>Public</th>
<th>Private</th>
<th>Shared</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Political</strong></td>
<td>Direct political</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Political Decision making</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Competing facilities</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Regulatory</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Protectionism</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Legislation change</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>Pre-investment</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Tolls Revenue</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Financial</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Cost overrun</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Socio-Cultural</strong></td>
<td>Public opinion</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Moral Hazard</td>
<td></td>
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<td>X</td>
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<tr>
<td></td>
<td>Partnering</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td></td>
<td>Environmental Justice</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td>Project management</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Construction</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Design and latent defect</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Environmental</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Technology</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Force majeure</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Physical</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

*Most of the risk factors were identified and defined by Li, Akintoy, Edwards and Hardcastlea (2004).*
As the PEST framework suggests, the risk factors as shown in Table 2, can also be categorized according to which phase the risk lies in. The four phases of construction are Planning, Pre-construction, Construction and Operation and Maintenance (FHWA 2006). Table 3 shows the categorization of risk factors into phases of construction where the risk is most likely to occur. The Planning phase is the first stage of construction project which includes the identification of the location and pre-design of the building or facility. In this stage, the project details are not yet defined and environmental reviews are incomplete. The public support and funding is also not committed in this stage. The risks include uncertain political and public support and competing interests and competing projects. The Pre-construction phase involves defining project goals (project scope, cost and schedule well defined), environmental reviews, initial approvals such as those of construction approvals, including permits and agreements. The issues include the land uses risks, changes in design requirements, environmental issues that could build up during the project, funding uncertainty, market conditions and permit requirements. The Construction phase starts when the design is complete along with the funding and policy. There could be issues of contractor performance, construction quality, technological advancement, final permitting, and changes in design and unanticipated site/working conditions. Once all construction is complete, the operation and maintenance phase of a construction project begins. This is a stage where there could be risk of whether the toll revenues will be enough to recover the cost of the highway project or not and risk of environmental issues lie.

**Table 3 Risk factors from PEST framework into different phases of construction**
The PEST framework also proposes that the risk factors can show risk dependencies within the category. The state diagram has been implemented to show the dependencies of each risk factor within the category. State diagrams are used to describe the behavior of a system (Gooch 2000). State diagrams describe all of the possible states of an object as events occur. State diagrams are mostly used in computer science to describe behavior of systems. For PEST framework, the state diagram is useful as the impact or dependency of the risk factors can be clearly envisaged. This will help in contingency planning and looking at the risks from macro level. The risk factors are assigned a letter and a number. As part of state diagram representation of risk, three risk dependencies are checked, whether the risk factors are contingent, independent or mutually exclusive. Contingent risks are those which can result or affect other risk factors and can also be dependent of other variables (risk factors). Independent risks are those which can occur at the same time or different time during different phase of construction and are not completely related to each other. Mutually exclusive risks are those risk factors that cannot occur at the same time. Three conditions are set up, where R1 and R2 are risk factors 1 and 2 respectively:

I. R1 → R2
   R2 is dependent on R1. Risk dependency – Contingent

II. R1 U R2
    R1 and R2 are independent of each other and can occur at the same time or at different time during different phase of construction.

III. R1 ↔ R2
    R1 and R2 are mutually exclusive.

Figure 2 shows the risk dependencies among the risk factors in Political category of the PEST framework. Direct political risk has impact on the decision making. The legislation change can result in change in the regulatory laws, protectionism policy and also impact on the political decision making, whereas political decision making could also lead to legislation changes. For example, due to lack of strong support at state level, the Port of Miami Tunnel (POMT) project remained in the planning stage for two decades. This helped in bringing together the stakeholders and created a mutually-agreeable financing and delivery solution among the project sponsors. The competing facilities risk is independent risk factor in the political category.

Figure 2 State diagram showing risk dependency of Political risks
Figure 3 portrays the risk dependencies of the economic risk factors. The tolls revenue has direct impact on the financial risk. In P3 projects, it would be expected that the private party could request cash compensation from the government/public party for a deficiency in income from fares or tolls, request authority to increase tolls or fares, or extend the concession period. It is necessary to identify its risks clearly with respect to cash flow or its returns, as they may be affected by an extended concession period. The anticipated toll revenue could be over or underestimated. Pre-investment risk is independent as it occurs during the planning stage.

![Figure 3 State diagram showing risk dependency of Economic risks](image)

Figure 4 shows the dependencies of risk factors within the socio-cultural category of the PEST framework. Transparency or public opinion is an essential aspect that needs to be considered. If the risk of moral hazard takes place that is the information does not flow clearly from one part to another whether intentionally or not, this could lead to conflict between the partners, hence partnering risk may arise. If there are environmental issues, then there can also be risk of public opinion. Transparency or public opinion and moral hazard are mutually exclusive. If all the project activities are transparent and public opinion is favorable then the likelihood of moral hazard is minimal.

![Figure 4 State diagram showing risk dependency of Socio-cultural risks](image)
Figure 5 shows the risk dependency among the risk factors among the technical category of the PEST framework. Most of the risk factors in this category are contingent, which results in other risks. For example, if there is lack of technology advancement in the equipments, applications, it might lead to less productive construction works and hence the construction risk. The project management decides on the level of technology, so this decision has impact on the technology as well as construction. Force majeure risk is a risk of uncertain activities that has adverse effect on construction. This could also cause damages in labor, equipment during the construction and lead to cost overrun and project delay.

**Figure 5** State diagram showing risk dependency of Technical risks
Table 4 summarizes figures 2, 3, 4 and 5.

Table 4 Risk dependency of risk factors in PEST framework

<table>
<thead>
<tr>
<th>PEST category</th>
<th>Risk factors</th>
<th>Risk dependency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Political Risks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct political</td>
<td>P1 P1</td>
<td>contingent</td>
</tr>
<tr>
<td>Political Decision making</td>
<td>P2 P2</td>
<td>contingent</td>
</tr>
<tr>
<td>Competing facilities</td>
<td>P3 P3</td>
<td>independent</td>
</tr>
<tr>
<td>Regulatory</td>
<td>P4</td>
<td>contingent</td>
</tr>
<tr>
<td>Protectionism</td>
<td>P5</td>
<td>contingent</td>
</tr>
<tr>
<td>Legislation change</td>
<td>P6</td>
<td>contingent</td>
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<td>E1 E1</td>
<td>independent</td>
</tr>
<tr>
<td>Tolls Revenue</td>
<td>E2 E2 E3</td>
<td>contingent</td>
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<tr>
<td>Financial</td>
<td>E3 E3 E4</td>
<td>contingent</td>
</tr>
<tr>
<td>Cost overrun</td>
<td>E4 E4 E3</td>
<td>contingent</td>
</tr>
<tr>
<td><strong>Socio-cultural Risks</strong></td>
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<tr>
<td>Public opinion</td>
<td>S1 S2 S1</td>
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<tr>
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</tr>
<tr>
<td>Moral Hazard</td>
<td>S3 S5 S1</td>
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<tr>
<td>Partnering</td>
<td>S4 S1 S3</td>
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</tr>
<tr>
<td>Environmental Justice</td>
<td>S5</td>
<td>exclusive</td>
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<tr>
<td><strong>Technical Risks</strong></td>
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<td>T1 T1 T4</td>
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<td>T2 T3 T2</td>
<td>contingent</td>
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<td>Design and latent defect</td>
<td>T3 T4  T2</td>
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<td>Technology</td>
<td>T4 T5 T1, T2</td>
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<tr>
<td>Force majeure</td>
<td>T5 T6</td>
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<tr>
<td>Physical</td>
<td>T6</td>
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IDENTIFICATION AND ANALYSIS OF RISK

Due to the uniqueness in the risk profile of P3 projects, comprehensive identification of risk factors is critical. Most of the risk identification techniques in P3 projects are based on the knowledge of experts in related fields and having experience with similar projects. Risk identification is finding out which risks are likely to affect the project; and documenting the characteristics of those risks. Risk identification should be performed on a regular basis throughout the project (Deviprasadh 2007). Risk identification is also concerned with opportunities (positive outcomes) as well as threats (negative outcomes). The risk identification techniques include questionnaire survey, workshops, and feedback from similar projects, discussions and brainstorming sessions with specialists, experienced advisers, project managers, government representatives, stakeholders and users (Fischer et. al 2010).

Development of a risk checklist (or catalogue) is one of the methods of risk identification (Li et. al 2004). Identification of risk factors could also involve collection of information from different P3 highway project case studies and information from the agencies in which they operate. For an empirical quantitative analysis, data can be collected by using some survey methods. The target survey respondents of the questionnaire can include all industrial practitioners from the public, private, and other sectors as well as academic researchers. Usually, the contractual parties use interviews with experts, checklists of generic risks along with document reviews. Generally, it would be best to use multiple methods as opposed to relying on a single method for data collection.

The PEST framework can help in clustering the risks according to their causes so that risk groups are free from redundancy. It can be used to provide a basis for standardization.

The risk identification and risk analysis processes can be complex, but the results can be valuable. Appropriate risk analysis methods/ processes will result in proper allocation of risk factors and help in decision making.

Risk quantification consists of evaluating risks and risk interactions to assess the range of possible project outcomes. A single risk factor can result in many adverse effects. The most common tools for risk analysis include decision trees, influence diagrams, Monte Carlo simulation, and sensitivity methods (Han and Diekmann 2004). A decision tree is a diagram that depicts key interactions among decisions and associated chance events as they are understood by the decision maker. The branches of the tree represent either decisions or chance events are examples of a decision tree (Deviprasadh 2007).

There are several tools and techniques for risk quantification. One of them is expected monetary value which is the product of two numbers: risk event probability-an estimate of the probability that a given risk event will occur; and risk event value-an estimate of the gain or loss that will be incurred if the risk event does occur. Another way of risk analysis is by simulation and by expert judgment. Simulation uses a representation or model of a system to analyze the behavior or performance of the system. Expert judgment could also be applied by describing the risk as having a high, medium, or low probability of occurrence and a severe, moderate, or limited impact.
ANALYTICAL TOOL FOR PEST FRAMEWORK

For analysis of the risk factors of P3 projects, which have been categorized using the PEST framework, the influence diagram could give the decision makers visual representation of where and how most of the risk lies, and dependency of who bears these risks and its outcomes. The influence diagram is a graphical representation of the decision problem and a way of describing the dependencies among variables and decisions. It can be used to visualize the probabilistic dependencies in a decision analysis and to specify the states of information for which independencies can be assumed to exist (Howard and Matheson 2005).

In case of PEST framework, the influence diagram also shows the outcomes of the risks for all the four categories. Different color codes are used to show which party mostly bears which kind of risk. The different parties bearing the different risks are differentiated by three colors. The red lines denote that most of these types of risks are borne by the public party, whereas blue lines denote that the private party bears these risks. The green lines show that both the parties share these risks. Figures 6, 7, 8 and 9 show the risk factors categorized by the PEST framework through the influence diagram. Different color coding denotes which parties bear the risk whether public, private or if the risk is shared. The outcomes of each potential risk are denoted by the diamond shapes. This type of representation will help them in strategizing the risk mitigation and management. From the figures, we can see that most of the risks are borne by either private party or are being shared between private and public party.

Figure 6 shows the political risks through influence diagrams. For example the direct political risk is borne by the public party denoted by red. The outcomes could be public outrage or public acceptance. If the public outrage occurs, the consequences could include currency inconvertibility and transfer restriction, expropriation, breach of contract, political violence, legal, regulatory and bureaucratic risks, and non-governmental action risks. The political decision making risk which is shared between private and public parties could result into endless discussions. For example for getting the environmental clearance in case of the South Bay Expressway (SR 125) Toll road project in San Diego County, California, it took them nine years to get the approval. This is a direct political risk which was borne by the public party. The competing facilities risk factors might affect revenue and could result in financial difficulties. Risks like protectionism and legislation change could result in litigations, public outcry, and bad publicity as well as re-evaluation, re-bidding and change in tax law.

Figure 7 demonstrates the economic risks (from PEST) through the influence diagram. Most of the risks in this category are shared between both the public and private parties. The risks like pre-investment could result in either the loss or winning of contract which could affect the project budget of the project. Toll revenue could be either over or under estimated which leads to financial difficulties. The financial risk and cost overrun risks could result in public finance constraints and effect on credibility.

Figure 8 represents the socio-cultural risks which include shared risks such as transparency, environmental issues, moral hazard, and environmental justice. The outcomes of transparency could lead to public skepticism about the real benefits of P3 projects, environmental issues leading to pollution, protest and bad publicity of the project itself. The shared risk also includes partnering risk which if conflicted could affect the efficiency in resource allocation, including indirect effect on taxation, public finance, distributive effects among individuals, social groups, regions, etc.

Almost all of the technical risks are borne by the private party except the construction risk. Figure 9 illustrates this. These are shown by blue color. A risk that falls in this category is project management, which if inept can delay the project as well as go over budget. Other risks are of construction, design and latent defect and physical risk. The outcomes of which directly or indirectly
have affects on the project schedule, resources, budget, and rework, productivity and performance or the quality of the product or services. Technology is also one of the risks which have affects on efficiency. The unexpected risk that is force majeure could also effect in schedule delay and additional expenses.

From the influence diagram, we observe that the outcome of each risk, that are under certain P, E, S, and T grouped together in the PEST framework, are similar, or is cause of similar events or can have similar negative consequences. Therefore, the PEST framework can help the practitioners and decision makers to devise a general risk mitigation strategy which could help reduce the impact of similar risks with similar consequences. Though each risk might need to be handled differently in a case by case basis, this framework with influence diagram shows broader generalization of risk categories impacting same aspects of the project and which party is most involved or is impacted by different groups of risks identified in framework.

Figure 10 shows the risks that were involved in the Chicago Skyway Project. The influence diagram has been used in this case study to show the risk factors, its category and its outcomes. In the case of Chicago Skyway project, the PEST framework is useful to group similar risk into the categories. The influence diagram shows different categories, the risks and their outcomes. For example, the concession agreement in the project was a fully enforceable contract between the Cintra-Macquarie team and the City of Chicago which was approved by a vote of the Chicago City Council. At that time, the mayor and those who remained in the office were satisfied by the agreement. But as time goes by these people will be replaced by other people over the span of the ninety-nine year lease term. So there could be a Political risk of decision making involved in the future when the staffs will be replaced. PEST framework groups this risk under the Political Risks.

The project also faced some economic risks which the PEST framework grouped under Economic risks of PEST framework as shown in Figure 10. The project faced difficulties in calculating net-present value of ninety-nine year lease. The lease term was of 99 years and this makes evaluating value of a-year concession using net present value difficult as a basis as proceeds from much of the concession period do not affect the result. The wide variance in bids for the Skyway from a low of $505 million to the winning bid of $1.83 billion illustrates the methodological difficulties inherent in measuring the value of such a long-term investment.

Hence the PEST framework along with the influence diagram is helpful to group and visualize the risks and see who bear the risk. This will help in coming up with remedial strategies and better decision making.
Figure 6 Influence diagram and PEST framework showing the Political risks and its outcomes
Figure 7 Influence diagram and PEST framework showing the Economic risks and its outcomes
Figure 8 Influence diagram and PEST framework showing the Socio-cultural risks and its outcomes
Figure 9 Influence diagram and PEST framework showing the Technical risks and its outcomes
Figure 10 Influence diagram and PEST framework showing the risks and its outcomes in Chicago Skyway Project
CASE STUDIES

The following Public Private Partnership projects were reviewed to show implementation of PEST framework. The risk factors involved with them were categorized according to the PEST framework. This will help the practitioners in the future to visualize where most of the risks lie. Having the categorization will be beneficial for strategizing the risk mitigation plans as well as in risk management.

1. Chicago Skyway Operating Lease, Illinois
2. Port of Miami Tunnel, Florida

1. CHICAGO SKYWAY OPERATING LEASE, ILLINOIS

The Chicago Skyway is a 7.8 mile elevated toll road connecting Chicago, Illinois and suburban northwestern part of Indiana. It is the primary highway facility approaching downtown Chicago from points south and east, connecting the Dan Ryan Expressway (Interstates 90/94) to the Indiana Toll Road (Interstate 90). The P3s involves a long-term operating lease in which the private sector concessionaire is Skyway Concession Company, LLC and the public party the City of Chicago. The cost of the project is $1.83 billion. The lease duration is for 99 years and was commenced in January 26, 2005.

Issues/Risks:

The risks that are involved in this project are categorized in the PEST framework as follows:

Political Risks (P):
- Direct Political Risk:
  - Future Political Uncertainty:
    Over a period of 99 years, there is a possibility of change in political scenario which could result in overturn with the agreement especially when the original cash proceeds to the city are spent. In order to protect from political tampering, the lease agreement has financial remedies due the concession team if the city were to prematurely terminate the deal or otherwise interfere with the ability of the concession team to generate revenue from the facility under the terms of the contract. Such penalties would place a significant financial burden on the city for reneging on the contract terms.

- Competing Facilities Risk:
  - Slower Population Growth in Neighboring Indiana Counties who’s Commuters Use the Skyway:
    The Indiana DOT and Illinois DOT freeways comprising I-94 and also the Illinois State Toll Highway Authority’s Tri-State Tollway (I-294) offer alternate routes from Indiana to the city and its Illinois suburbs. This may lead to some traffic diversion to the improved facilities.
    The population growth is expected to be much slower over the next 30 years in northwestern. This slower population growth in the counties that are
home to most Skyway commuters may limit growth in toll revenue on the facility relative to projections based on recent trends.

Economic Risks (E):
- Financial
  - Difficulty Calculating Net-Present Value of Ninety-nine Year Lease:
    Standard financial planning techniques apply a discount rate to future revenues to calculate the net present value of an investment. When the time horizon of analysis stretches beyond a 20 or 30 year period (depending on the discount rate applied), the net present value of proceeds in outer years becomes negligible. This becomes problematic when evaluating the value of a-year concession using net present value as a basis as proceeds from much of the concession period do not affect the result.

- Regulated Toll Regime that Makes No Allowance for Facility Congestion:
  In the near term, critics of the Skyway concession will fault the city for allowing tolls to double over a span of 12 years, from 2005 to 2017. Beyond 2017, tolls may grow at the fastest of several rates of inflation or a minimum of 2 percent. To remedy this situation, the lease agreement would need to be amended permit congestion pricing when the facility reaches a level of service that causes a reduction in throughput capacity. This could produce a significant windfall to the concession team. To avoid public backlash against the imposition of congestion pricing and the earning of excessive profits by the concession team, the increased revenues resulting from congestion pricing could be dedicated to or shared with the city.

2. PORT OF MIAMI TUNNEL, FLORIDA

The Port of Miami Tunnel (POMT) is a roadway project that connects South Florida’s Interstate highway network to the Port of Miami (POM). The POMT will route much of the Port-related traffic directly onto nearby Interstate highways. The POMT project is sponsored by the Florida Department of Transportation (FDOT) in cooperation with Miami-Dade County, the Port of Miami and the City of Miami. The development of the project is through P3. The Miami Access Tunnel will be responsible for the design, construction, and financing, operation and maintenance of the facility for 30 years. There will be no direct fees or tolls charged to users of the tunnel facility. The concessionaire will receive availability payments from FDOT throughout the duration of the contract in exchange for maintaining a predetermined level of availability, service quality, and safety on the facility.

Issues/Risks:

The risks that are involved in this project are categorized in the PEST framework as follows:

Political Risks (P):
- Strong Political Support is Necessary:
  Due to lack of strong support at state level, the POMT project remained in the planning stage for two decades. This helped in bringing together the stakeholders
and created a mutually-agreeable financing and delivery solution among the project sponsors.

Economic Risks (E):
- *Multiple Stakeholder Participation in Project Financing:*
  This problem was solved by the sponsors in Florida by putting the responsibility for initial project financing on the private sector and then the public sector sponsors pay back those costs over time. The funding responsibility is divided between FDOT, Miami-Dade County, and the City of Miami.

Technical Risks (T):
- *Obtaining Cost-Effective Bids from the Private Sector for a Mega-Project:*
  FDOT had risks involved regarding getting the cost-effective bids in from private parties in the beginning. With the change in procurement structure which included risk-sharing mechanisms; a Value for Money analysis FDOT was able to get multiple competitive bids from qualified consortia.

We observed that risks identified in both projects could be grouped into categories. Some risks are more likely in one project than another and may even not be evident in some projects. All major projects risk could be categorized in one of the categories of the ‘PEST’ framework proposed. In the above two case studies, it is seen that the risk associated with the Political uncertainty in the case of Chicago Skyway is somewhat related to Political support needed for Miami Tunnel project where both risks are categorized under one umbrella of Political Risk. These both risks to the projects were due to political uncertainty and support in short term or in long term. These types of political risks need further analysis and some kind of common mitigation strategies that can be devised to mitigate in the proper ways. Overcoming, Political risks (P), one major risk category, is very essential for the success of P3 projects.
CONCLUSIONS

The primary motivation for using P3 is due to the failing of the traditional approach to adequately fund transportation project delivery. One of the major benefits of using P3 projects is that the risks involved can be managed by allocating expected risks to the party who is best able to manage them. The risks identified during the P3 highway construction projects are categorized in PEST framework based on Political, Economic, Socio-cultural and Technical risks. The PEST framework categorizes the different risk factors according to parties responsible for risk management; different phases of construction: planning, pre-construction, construction, or operation and maintenance or; project types: greenfield or brownfield; and according to risk dependencies: independent, contingent or mutually exclusive. By illustrating risks according to types of projects, phases of construction and risk dependencies gives visual understanding of risk distribution for contingency planning. The risk categorization can help practitioners on evaluating risks as a category and devise common risk mitigation strategies adding value to risk analysis.

The analytical tools such as influence diagram and state diagram further expands in analyzing the risks identified by visual representation. The PEST framework when analyzed based on these tools helps identify the risks impact and dependencies. This categorization of risk factors can also help identify the parties involved (public or private) that assume the most risk based on different phases of highway construction and the type of risk involved within it.

Due to the lack of substantial project quantitative data, this paper is limited to assumption of possible risks and its dependencies during a P3 project. Mixed methods of data collections including surveys can be used to quantify the risk factors and determine the probabilities of risk occurrence. Further studies could also include the risk analysis of the data that are outcome of the risk factors which have been categorized in the four groups in this research.
REFERENCES


