LEAN PRINCIPLES APPLICATION IN PUBLIC-PRIVATE PARTNERSHIP PROJECT PROCUREMENT

Ramtin Malek

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Committee:
Ghada Gad, Advisor
Alan Atalah
Wilfred Roudebusch
With the budget pressures that state Departments of Transportation (DOTs) are facing, slow revenue growth, congestion resulting in a need for new highway capacity, increasing costs of aging infrastructure maintenance, and construction costs, in addition to, traditional delivery methods falling behind on meeting those complex challenges, there is a crucial need to employ new innovative project delivery methods, such as, public-private partnerships (PPPs). However, the additional risks associated with PPPs from the integration of the operation and maintenance phases need crucial attention during the procurement stage. With 55% of PPP projects being renegotiated between the public and private sectors after 3 years of project award, the significant effect of operation and maintenance risks clearly emerges. On the other side, lean application has been proven to achieve sustainability through enhancing value and eliminating waste which could offer potential for improvements in PPP projects. The objective of this study was to investigate the importance of lean assessment during the procurement phase in PPP projects from the DOTs and project managers’ (PM) perspectives. To achieve this objective, a concurrent mixed research method, employing surveys and interviews, was used. Surveys were sent to the 33 DOTs that have PPPs legislation, to investigate if lean was considered as one of the evaluation criteria in their bid documents. In addition, six interviews were conducted with PMs experienced in both PPP projects and lean application in construction to get their opinions about what lean meant and what benefits could be realized from employing lean in PPP projects. Results of the survey showed that 37% of state DOTs were not familiar with lean definition. In addition, none of the state DOTs reported considering lean applications as one of the evaluation
criteria in their bid documents. As for the interviews, the PMs indicated the significance of contractors’ lean experience in successful PPP projects. It was concluded that lean could be defined as “structured continuous improvement” and the two important risks that can be assessed by implementing lean in PPP projects are project and operation changes and operation and maintenance cost overruns.
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CHAPTER I: INTRODUCTION

This chapter presents the problems and risks in Public-Private Partnership projects and explains the potential advantages of implementing lean in PPP projects. Also the objective and advantages of this study will be elaborated.

Context of the Problem

State departments of transportation (DOTs) are facing a lot of challenges such as budget pressures, slow revenue growth, congestion resulting in a need for new highway capacity, increasing costs of aging infrastructure maintenance, and construction costs, in addition to traditional delivery methods falling behind on meeting those complex challenges. All these challenges create a crucial need to employ new innovative project delivery methods (PDMs), such as, Public Private Partnerships (PPPs). As DOTs work to meet citizens' transportation needs given limited financial resources, the number of state DOTs that pursue and consider PPPs as an integrated project delivery method to procure transportation infrastructure is continuously increasing. This is owing to the fact that the early involvement of the private sector brings creativity, efficiency, and capital to address complex transportation problems facing the public sector. The other reason from DOT’s perspective to use PPPs is to construct and provide more infrastructures for residents without having the whole budget at the beginning of the project. Therefore, the DOT can have enough money left in their budget to construct and maintain other facilities. Also, citizens will pay less tax to use new infrastructures.

There are many types of risks in the construction industry such as technical, construction, operations, revenue, and financial risks which can occur until the end of the contractual agreement. Hassan (2013) mentioned cost overruns, schedule delay, poor quality, disputes and litigations, low productivity, and poor safety as the most common challenges in Integrated
Project Delivery such as PPP projects. Furthermore, with long term agreements in PPPs that lasts from 20 to 99 years, more uncertainty and risks are introduced to the project life cycle and could also be amplified if not assessed adequately.

Also, a case study in the United States has shown that PPP projects can be more expensive than other PDMs, considering them “wasteful and risky” due to the long term concession (Bloomfield, Westerling, & Carey, 1998).

In addition to risks, construction is yet known to be one of the most wasteful industries, which could be amplified in a long concession period involved in PPP projects (Gallaher et al., 2004). Waste refers to *any activity* that adds cost but adds no value or less value based on customers’ needs in comparison with the added cost (Lapinski, Horman, & Riley, 2007). In general, waste can be result of lack of management skills. In the construction industry, however, waste can occur because of poor management skills of both parties: owners and contractors. More specifically, in PPPs, the concessionaire is responsible for producing the service, individually implementing any cost innovation, and directly collecting money from the end users (Engel, Fischer, & Galetovic, 2013). Thus, PPPs need the skills and expertise of the private sector to provide public services and facilities during the long term concession. Therefore, PPP is not simply about the financing of capital investments like Design-Bid-Build, but about exploring the full range of private sector management, commercial and creative skills to reduce waste and risks (Nisar, 2006).

In this regard, lean application is one approach used to achieve sustainability through enhancing value and eliminating waste. Lean application was proven not only to show improvement in speed but also to create better quality outputs and costs reduction especially in traditional PDMs (Parnell-Klabo, 2006). Therefore, it would be worth investigating if
implementing lean in PPP projects and private sectors’ experiences in lean principles could result in higher quality projects with less cost to the owners and the public in the long-term.

The decision for selecting PPP projects as a PDM often involves great uncertainty because it is made at the beginning of a project when only limited information is available (Ibbs and Chih, 2011). Thus, having appropriate evaluation criteria set for bidders during the proposal stage can help both parties, DOTs and contractors, decrease the risks associated with the PPP projects. There is no doubt that selecting experienced contractors can result in the success of such a long term agreement.

Many studies have been conducted to investigate the evaluation criteria used in PPPs’ Request for Qualification (RFQ) and Request for Proposals (RFP) such as technical qualification, relevant experience, and financial capability (Ismail, Takim, & Nawawi 2011; Aziz 2007; Zhang 2007 & 2005; Gransberg & Barton 2007). On the other side, lean application was addressed in other PDMs such as Becker's et al. (2012) study that introduced lean advantages in design-build procurement as “collaborative innovation, risk reduction, and schedule acceleration.” Although various evaluation criteria were investigated by researchers to investigate the level of contractor’s expertise in constructing infrastructures in PPPs, examining the management skills and commitment to provide more integrated PDM is always questionable. Even though Hassan (2013) mentioned the significance impacts of lean in final success of IPD projects rather than Design-Bid-Build, no research was conducted to investigate the employment of lean principles as an evaluation criterion in PPP procurement process. Therefore, this research aimed to investigate if lean was used as a specific category by DOTs as one of the evaluation criteria in the proposal process of PPP highway projects’ RFQ and RFP documents and not only the financial and previous experience of contractors.
Statement of the Problem

Due to DOTs’ budget pressures, slow revenue growth, increasing costs of aging infrastructure maintenance, and construction costs, the demands for delivering projects using the PPP delivery method is increasing. As a result, the DOTs should encompass the evaluation criteria which can properly assess risks and decrease waste by ensuring that PPPs’ contractors are continuously improving their functions. On the other side, lean as one of the evaluation criteria offers a variety of options to continuously improve the project and better waste management in such a long concession period. Consequently, this study investigated DOTs’ evaluation of the private sectors’ lean experience during the bidding process together with project managers’ opinions about benefits of lean principles in PPP highway projects.

Objective of the Study

The objective of this study was to investigate the importance of lean assessment during the procurement phase in PPP projects from the DOTs and project managers’ perspectives. In order to achieve the main objective, four research questions needed to be addressed. These questions are as follows:

1. How many DOTs are currently using lean as one of the evaluation criteria in the bidding process?
2. How much weight do DOTs allocate to lean in evaluating proposals?
3. What is the definition and what are the advantages of lean and lean principles?
4. How is lean addressed as an evaluation criterion in RFP and how can it be addressed by contractors in their proposals?

The first and second questions were investigated by survey among DOTs which have PPP legislation. The third and fourth questions were addressed by literature review and
interviewing with project managers experienced in PPP and lean. At the end, the results were presented and the conclusions were drawn.

Significance of the Study

Although PPP can be used to reduce the financial challenges of the public sector to construct highway infrastructures, it can bring more risks due to its long term agreement setting. It has been proven that the longer the project life cycle, the more risks and uncertainty such as financial problems, cost overruns, poor quality, and delays are associated with the project (Grimsey & Lewis 2002; Iyer & Sagheer 2010; Shrestha 2011; Hassan 2013; Preston, Ellis, & James 2009). Therefore, both public and private sectors should be prepared to assess those risks early on. Having proper evaluation criteria for selecting the contractor is the first crucial step in any kind of PDM in ensuring having experienced contractors that can address such challenges. In PPPs, these evaluation criteria play a significant role for project success owing to the long project life cycle duration. On the other side, the advantages of implementing lean principles to decrease the risks and overcome those problems have been proven in many studies. Therefore, implementing lean principles in PPP projects might have the potential to reduce the risks associated with these problems and can eliminate the future risks and waste for both sectors in this long-term agreement. The objective of this study was to investigate how important lean was from the DOT’s and project managers’ perspectives in PPP projects. The advantages of this research are:

- Making both sectors, DOTs and contractors, more familiar with lean definition and advantages
- Recommending lean characteristics which can be asked and evaluated in contractors’ proposals
Helping both sectors to have the same understanding of lean and its advantages can boost the integrity of PPP projects and can help flourish the implementation of PPP projects from DOTs, which can result in less wasteful projects that can help both sectors to have more money left and more satisfied end users.

Assumptions/Limitations

There were two different method of data gathering for this study. For the survey, it was assumed that all states with PPP legislation have established a framework for evaluation criteria. Consequently, all 33 states were directly asked if they use lean as one of the evaluation criteria.

For the interviews, the criteria of five year experience in PPP projects in the US as well as two year experience in lean made recruiting participants more challenging. In addition, having a one hour phone interview was considered time consuming for many project managers. Therefore, although six interviews were considered sufficient for this study, more interviews could have helped to draw more conclusions.

Definition of Terms

Several noteworthy terms which have already been used or will be used later in this study are defined on the table below. These definitions are based on how the term is used in this study and are ordered alphabetically.
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<th>Term</th>
<th>Definition</th>
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<tr>
<td>IPD</td>
<td>Integrated Project Delivery</td>
<td>A collaborative project delivery that optimize project result in terms of adding more value to the owner, reducing waste, and increasing efficiency (Hassan, 2013)</td>
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<td>LC</td>
<td>Lean Construction</td>
<td>Tools and principles of lean that can be used in construction (Diekmann et al., 2004)</td>
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<td>LP</td>
<td>Lean Principles</td>
<td>The principles used for achieving lean objective (see literature review for more detail)</td>
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<td>LPSt</td>
<td>Last Planner System</td>
<td>It is a production planning system tried to produce predictable work flow and accelerate the learning process (Becker et al., 2012)</td>
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<td>LT</td>
<td>Lean Thinking</td>
<td>Philosophy that helps to achieve lean goals</td>
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<td>PDM</td>
<td>Project Delivery Method</td>
<td>A system with a legal agreement used by the owner to design, construct, operate, or maintenance of a facility</td>
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<td>PPP</td>
<td>Public-Private Partnership</td>
<td>A contractual agreement that forms between public and private sectors, which allows more private sector participation than in traditional. The agreements usually involve a government agency contracting with a private company to renovate, construct, operate, maintain, and/or manage a facility or system. (Federal Highway Administration, 2013)</td>
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<tr>
<td>POP</td>
<td>Product-Organization-Process</td>
<td>Generic framework of producing, organizing, and processing. (Khanzode, Fischer, Reed, &amp; Ballard, 2006)</td>
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<tr>
<td>RCA</td>
<td>Root Cause Analysis</td>
<td>RCA is the process to identify, solve, and prevent the main cause of problems. (Sarkar, Mukhopadhyay, &amp; Ghosh, 2013)</td>
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<tr>
<td>TPS</td>
<td>Toyota Production System</td>
<td>An integrated production system that Toyota uses to boost its management philosophy and production</td>
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<td>VDC</td>
<td>Virtual Design and Construction</td>
<td>Using software to virtualize the facility before starting to construct it. (Khanzode et al., 2006)</td>
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<td>VSM</td>
<td>Value Stream Mapping</td>
<td>It is a method that focuses on the process of making a product. (Parnell-Klabo, 2006)</td>
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CHAPTER II: LITERATURE REVIEW

This chapter discusses Public-Private Partnership projects and lean in more detail. PPPs definition, advantages, risks, and structures will be discussed. Then different scholars’ opinions about lean definition will be provided. Lean principles and lean tools will be presented in more detail and lean advantages will be discussed.

Public-Private Partnerships

Integrated Project Delivery (IPD) is a project delivery approach that collaboratively utilizes all participants’ experience and talents to optimize project productivity by implementing integrate systems and business structures (Hassan, 2013). PPP procurements are one approach of IPD in which DOTs, contractors, financial organizations, and stakeholders collaboratively work to maximize the project productivity as well as respond to clients’ needs. Based on the Federal Highway Administration (2013), PPPs are an innovative project delivery method in which the public sector will still remain responsible for the facility; however, the private sector will perform all tasks of the government during the contract commitment. Bloomfield (2006, p. 405) elaborates on FHWA’s definition of PPPs as “complicated long-term contracts with private companies for some combination of services, construction, or financing in return for some combination of public funds, public assets, or user fees in which mutual benefits are sought and where ultimately the private sector puts private finance at risk.”

Procurement of PPP Projects

PPP projects are procured in two different ways: solicited or unsolicited. In solicited proposals, DOTs invite private sectors to provide their proposals for predetermined projects while in unsolicited proposals, private sectors provide their proposals for projects that are not included in public sectors’ plans (Federal Highway Administration, 2010). In either case, the
private sectors’ proposals are evaluated by the public sectors, DOTs. In order for private sectors to participate in PPP projects, concessionaires should be formed. Concessionaires, Special Purpose Vehicles or Special Purpose Entities, are a combination of firms that establish a joint venture to bid on a PPP project. Before awarding the contract, the concessionaire is responsible for the providing the proposal, arranging for the financing, and negotiating agreements with public sectors (The World Bank, 2012).

The evaluation of concessionaires’ proposals can be done in two manners: single-stage bid process and two or multi-stage bid process. The former includes both technical and financial proposals from the private sectors. Under the latter approach, however, the bidders present the initial proposals which include comments on the RFPs and draft contracts. Also, the proposals may or may not include the financial bids on the latter method. Then the public sectors review the initial proposals and revise the RFPs and draft contracts. Negotiations with bidders are conducted by public sectors and some bidders may be eliminated at this stage. At the end, the remaining bidders submit their final proposals including final financial bids. Although single-stage bid process is the quickest and simplest method, the advantages of two or multi-stage bid process are enough to be the most popular method from DOTs’ perspectives. These advantages are more room for innovation, higher quality of final proposals, and getting closers to DOTs’ needs.

There are two options for evaluating proposals and selecting preferred bidders:

- Selection based on financial criteria: In this approach, there are two separate phases. First, bidders are asked to only provide their technical proposals. DOTs review and evaluate these proposals on a pass or fail basis. Bidders who pass this phase will be
asked to provide their financial proposals. Then the preferred bidders will be selected based on the financial proposals.

- Selection based on financial and technical criteria: In this method, both financial and technical proposals are requested simultaneously. DOTs allocate appropriate weight to each one of these criteria, financial and technical.

Although DOTs may negotiate with bidders to make more appropriate contracts that can respond to theirs interests, the evaluation criteria and weight allocated to each item in both approaches are always the most critical challenges in PPP projects (The World Bank 2012; Kerf, Gray, Taylor, Klein, & Ban, 1998). Zhang (2004) proposes two other evaluation criteria that should be considered (other than the financial and technical criteria) which are (1) health, safety, and environmental and (2) managerial.

Providing evidence for the different evaluation criteria by bidders and evaluating the accuracy of those criteria by DOTs can have a significant impact on the selection of the most appropriate bidders. On the other side, lean applications have been proven as a technical tool to enhance safety, and managerial characteristics of construction firms (Salem, Solomon, Genaidy, & Luegring, 2005, Salem, Solomon, Genaidy, & Minkarah 2006; Hassan, 2013, Koskela 1992, Jorgensen & Emmitt 2008; Arbos 2002).

**Post Award of PPP projects**

After awarding PPP projects to the appropriate bidders, five phases below should be done in order to successfully execute the projects:

1. Finance: Financing all or part of the capital expenditure. The Federal Highway Administration website (2013) defines the PPP finance structure as follows:
Figure 1.A illustrates how the finances of the design and construction phases are done. Most of the time, the lenders take more risks by paying more money than other sectors while the public sectors, DOTs, take fewer risks by paying less money. On the other hand, when the facility gets to the revenue phase, the DOTs will take more risks because they are responsible for the predicted revenue. If the revenue is less than what was expected at first, the public sectors are responsible for the difference. However, some DOTs have tried to assess this risk to contractors by stating that there is “no guarantee for the predicted revenue” in the contract. Although the general contractor will be funded by both lenders and public sectors for the design and construction phases, they will also participate in the initial finance process. The money which is brought by the general contractor is called “equity”. Figure 1.B shows the financial structure after the facility is constructed: operation and maintenance. The concessionaire, general contractor, is responsible for this phase. Also, the revenue from the toll will be gathered by the contractor under the DOTs’ supervision. The money left after the cost of operation and maintenance will be paid to shareholders, lenders, the public sectors, and equity as payments.
The third phase is the most critical phase of any PPP project because the parties will get paid based on the money earned in this phase.

2. Design: Developing the project from initial concept to construction-ready design specifications.

3. Build: Constructing the project and providing all necessary equipment. After designing the project based on the specifications, the concessionaire constructs the project.

4. Maintain: Maintaining an infrastructure to specified standards over the life of the contract. Although it is not necessary for the concessionaire to be an expert in all these phases and each phase may be contracted to the expert contractors by the concessionaire, the contractors’ experience and qualifications are asked before the project is awarded to the concessionaire. Maintenance is a cost that should be estimated by the concessionaire on bidding process.

5. Operate: Providing technical operation of the facility and directly servicing end users. This phase in highway PPP projects will usually accommodate toll and traffic control. The concessionaire is responsible for operating the facility and collecting tolls. The revenue of the project occurs during this phase.

Due to the complexity and risk under-taken by long-term contracts, local governments that hope to participate in this contractual commitment will continue to confront daunting management and governance challenges. The major issue in PPPs is the fear of the public sector that once the provision of public services is transferred over to the private sector, the management control will be lost and quality might be compromised (Zhang & Jia 2010; Chan et al. 2010; Iyer & Sagheer 2010; Edwards & Shaoul 2003; Leung & Hui 2005; Akintoye et al. 2003). On the other hand, as mentioned by many scholars, PPP projects can be completed faster
and with higher quality when one entity is responsible for the whole project (Meidute & Paliulis 2011; Aziz 2007; and Wang et al. 2000).

However, with the high risks associated with PPP, decision makers find it harder to choose this kind of PDM. Although PPPs’ private sector is responsible for finding investors and developing the finance structure, it is of utmost importance for public sector practitioners to comprehend private financing structures. In PPPs, renegotiation is part of many PPP procurements. For example, based on research in Latin American countries, 55% of transport concessions were renegotiated after an average of 3.1 years once the concessioners were awarded the projects (Guasch and Straub, 2006). The main reasons for this high incidence of renegotiation are initial tender processes, weak regulation, or opportunism on the part of the private or public sector. Interestingly enough, Guasch and Straub (2006) investigated that most renegotiations were favorable to the operator, resulting in increased tariffs, or reduced investment benefits. Therefore, in these cases, the main objective of the public sector to get into the PPP procurements cannot be achieved.

On the other side, it has been mentioned that the evaluation criteria for selecting the successful bidders have a crucial role to eliminate or decrease many risks, especially in a long term agreement like PPP projects (Iyer & Sagheer 2010; KarimiAzari, Mousavi, Mousavi, & Hosseini 2011; Ahadzi & Bowles 2004). There are many scholars that investigated the importance of financial criteria and value for money analysis as the main evaluation criteria in RFP for selecting the appropriate private sectors in PPP projects (Morallos, Amekudzi, Ross, & Meyer 2009; Grimsey & Lewis 2005; Ismail, Takim, & Nawawi 2011; Nisar 2006). Although this item has more weight in comparison with technical issues, the process for evaluating the latter should be investigated in more detail. Therefore, the question imposed is how the public
sector can ensure the private sector’s ability to implement the project faster, with higher quality, and meet the expected operation and maintenance cost through evaluation of the submitted proposals.

Lean

Lean has proven to accelerate the project in addition to create better quality outputs and costs reduction in traditional PDMs (Parnell-Klabo, 2006). Lean was introduced in 1988 by John Krafcik to describe the Toyota manufacturing system (Holweg, 2006). Many studies can be found that provide lean definition. However, no unanimous meaning can be concluded from their studies. Following are the definitions that were provided by previous scholars for defining lean:

Womack et al. (2003) defines lean as five principles that focus on how to add value in industries or services while simultaneously reducing waste. These five lean principles are the foundation and form the philosophy of Lean Production (Hassan, 2013):

1. Identify specific value: Identifying value based on the customers’ needs and desires.
2. Value stream: It includes three critical management skills to produce a specific product:
   - Problem solving task: running from idea through design to production process.
   - Information management task: running from taking order through scheduling for delivery.
   - Physical transformation task: proceeding from raw supplies to a finished product in the hands of the customers.
3. Flow: Once the value stream for a specific product has been entirely mapped by the lean enterprise, and wasteful steps are eliminated, then it is time for the flow. Flow is the
movement of the product through one value by adding steps to the succeeding value and keeping the product in one constant piece flow.

4. Pull: The ability to design, schedule, and make what exactly customers want, just when they want it.

5. Perfection: The fifth and the most important principle of lean thinking is continuous improvement to reach perfection, which is the process of reducing efforts, time, space, cost, and mistakes while offering the exact customers’ needs.

According to Hines et al. (2004), the most crucial aspect of lean concept is concentrating on value. They also argue that in most research, value creation is wrongly considered the same as cost reduction, which proves another failure of the understanding of lean. On the other hand, Ballard et al. (2007, p. xi) explains lean as “a fundamental business philosophy – one that is most effective when shared throughout the value stream,” which focuses on lean as a business strategy rather than the concentration of value. However, Alves (2012) and Parnell-Klabo (2006) state that lean is eliminating wasteful practices which do not add any additional value to the final product. Wasteful practices can be defined as:

1. Waiting or Delay: waiting refers to the periods of inactivity that occur because a preceding activity wasn’t delivered on time or finished completely. Waiting is a waste because it increases the cycle time during which no value-added activity is accomplished.

2. Motion: the unnecessary steps taken by people to accommodate an activity which takes time and adds no value to the product or service.

3. Over Processing: the extra steps in operations which adds no value to the product or service.

4. Over Production: when producing more than is needed or before it is needed.
5. Transportation: This is the unnecessary motion of products or materials.

6. Inventory: any supply of materials which is more than required to build the current phase of the project. Excess inventory can result in wasting money, resources, and also requires additional handling and space.

7. Correction or Defects: products, materials or services that do not meet owners’ expectation or conform to specifications and must be repaired or redone.

8. Talent or Creativity: Not completely utilizing employees’ talent (Hassan 2013; Alves 2012; Parnell-Klabo 2006)

Also, Alves (2012) clarifies that lean definition provides customers’ needs, when wanted, with no waste throughout the value stream, which provides a graphic swim lane diagram of all the procedural steps involved in producing a product or service and includes critical process metrics like cycle time, touch time, and queue time. In order to implement lean in manufacturing, documentation or mapping of the production process needs to be analyzed (Liker, 2004). However, before analyzing the process, Alves (2012) and McGill & Slocum (1993) mentioned that abandoning the previous experience of producing and attempting to find new ways of experiencing are two prerequisites for successfully implementing lean.

The process map helps to investigate the prerequisite, value, and waste associate to each process (Lapinski et al., 2007). For instance, at Toyota, the process map has resulted in significantly high levels of performance. Manufacturing lead times have been decreased by 48%, productivity have been raised by 53%, quality has increased by 65%, and 45% fewer engineering hours at a pace 24% quicker than any of Toyota’s U.S. rivals complete product development (Womack et al., 1990). Applying the lean principles to Toyota’s delivery process offers crucial
procedural guidance, which can be considered as the pioneer in implementing lean in manufacturing (Lapinski et al., 2007). Also, by applying lean principles, Lockheed Martin Missile and Space Corporation were able to decrease costs and program cycle times by 50% (Hassan, 2013).

These definitions of lean are applicable to the manufacturing industry. However, for achieving the same result of lean implementation in manufacturing for construction industry, some adaptations are needed owing to the fact that the construction industry is a more project based system with short-term teams allocated, different geographic projects and clients, and highly worker intensive and dependent tasks (Miller et al. 2009; Alves 2012). Adding those adaptations to lean manufacturing, Lean Construction (LC) was covered by Ohno (1988) and Shingo (1989) as a need to identify and exile waste in the construction industry by clarifying what waste meant for the industry, how it was created, and how it could be eliminated. Koskela (1992) made the first adaptations and defined LC as a theory of production management with 11 principles to eliminate the non-value added activities and boost the competitiveness of the construction industry. The first adaptation that Koskela (1992) made was viewing the construction performance as “flow processes” rather than “conversion processes” and called it a “new production philosophy.” Following Koskela’s research, Diekmann et al. (2004, p. iii) define Lean construction as “the continuous process of eliminating waste, meeting or exceeding all customer requirements, focusing on the entire value stream and pursuing perfection in the execution of a constructed project.” Making the definition more applicable to the construction industry than previous explanations, Green and May (2005) defined 3 different models of lean in the construction industry: waste elimination, partnering, and structuring the context. The latter one explains the need for “continuous evolution” and training as an essential piece of the
industry revolution toward lean construction application. This study mentioned lean training for resources as the main step for implementing LC. However, Jorgensen and Emmitt (2008) claimed that there is still an unclear logical philosophy for LC. In addition, Alves (2012) argues that there are still many recently published papers (e.g. Forsberg and Saukkoriipi, 2007) that define LC as the synonym of eliminating waste or increasing productivity and efficiency. Also, she mentioned that more research is needed to provide a uniform definition for LC to cover the same understanding of lean as in the manufacturing industry. However, McGill and Slocum (1993) clarify and confirm that the first prerequisite to successfully implementing lean is to abandon previous experiences and attempt to find new ways of experiencing.

Furthermore, another crucial point that has been raised by analyzing many studies (e.g. Alves 2012; Green and May 2005) is that many firms claim that they have been implementing lean concepts for many years, but a lean expert can easily realize this is not the case. Many of them may solely focus on a few concepts and tools of LC. Alves (2012) mentioned some actions, which many firms considered as implementing LC such as prefabrication and efficiency.

Although in the construction industry that unfamiliarity of many firms with lean has made it difficult to implement lean with some other methods, it is worth to mention that simultaneously implementing Six Sigma and lean leads to achieving lean goals faster in a wide ranging spectrum of industries. That is exactly what “lean Six Sigma” presents. Six Sigma helps the lean philosophy to tackle specific problems found in lean journey by using a statistical tool to measure defect rate within a system. The goal of Six Sigma is to reduce the number of defects to 3.4 for every million opportunities (Pepper & Spedding, 2010). Achieving this rate of defect in the construction industry with significant number of defects needs a prerequisite, familiarity with lean, that is currently missing.
After all investigation about lean concept and definition, the main question that comes to the author’s mind and also suggested for more research by Alves (2012) is how the owners can differentiate between firms that truly implement LC from those merely using LC as a part of their marketing.

Lean Tools

Some may claim that implementing all of the lean tools in the construction industry may not be possible due to its different environment compared to the manufacturing industry. However, there are still some tools that can be truly implemented in the construction industry. The Last Planner System (LPSt), value stream map, 5S, VDC, Kaizen, and root cause analysis are the most common lean tools that were mentioned in different studies for implementation in traditional PDMs.

Last Planner System (LPSt)/Pull planning: Ballard (2000) has defined Last Planner System (LPSt) and pull planning as the body of lean construction understanding. The Last Planner System makes crew promise to finish allocated tasks on an exact day (not earlier or later) thereby “reducing variability in task completion, boosting confidence in scheduling of following activities, and increasing the overall through-put of the collective project organization” (Becker et al. 2012, p. 188). On the other hand, Alves (2012) and Hines et al. (2004) claim that although LPSt is a main point of the most papers on project management in the International Group for the Lean Construction (IGLC) conferences, analysis of the original causes of the problems, and explanation of well-done activities and concentrating on value are more crucial than LPSt.

Value stream map (VSM): VSM is a preferred tool to focus on process. A VSM provides a visual swim lane illustration of the all process steps that need to be done to create a product or service. Three critical process variables that are focused on in VSM are cycle time, touch time,
and queue time. This will help project managers to avoid wasting time by having the cycle and touch time of each single task for the best, most likely, and worst scenarios. Also, it helps them to eliminate non-value-added activities and find an alternative to improve the process. (Parnell-Klabo, 2006)

5S: It is a tool to boost organization and efficiency of the work area by implementing five simple rules:

- Sort: Eliminate that which is not needed
- Set In Order: Organize remaining items
- Shine: Clean and inspect work area
- Standardize: Write standards for above
- Sustain: Regularly apply the standards

Virtual Design and Construction (VDC): One of the best methods that can be used in order to implement lean tools and, as a result, achieve lean objectives is VDC (Virtual Design and Construction). Although Alves (2012) challenges the companies that are doing VDC and consider it as using lean, the Center For Integrated Facility Engineering (CIFE) argues that using symbolic representations of a project in the form of Product-Organization-Process (POP) models is necessary for all IPDs in order to capture and simulate the project performance as well as adding more value to customers’ needs and eliminating waste (Khanzode et al., 2006).

VDC can be used in order to simulate the complexity and risks of the construction project delivery before any of the construction work ever starts in the real world. VDC helps owners and contractors to visualize symbolic models of POP. As a result, it can help both sectors to have a better Description, Explanation, Evaluation, Prediction, Alternative Formulation, Negotiation
and Decision (DEEPAND) about a project’s scope, which has more value from the owner’s perspective, organization, and schedule. (Khanzode et al. 2006; Garcia et al 2003). Since implementing the right tools of LP in car manufacturing industry has resulted in increasing the productivity by at least 2 times (Womack et al., 2003), it can be claimed that applying the proper method to implement lean tools, such as VDC, in the construction industry can result in a revolution in this most wasteful industry. Building Information Modeling (BIM) can also be used as a VDC tool to enhance the project visualization (Sacks, Radosavljevic, & Barak 2010).

Advantages of using VDC as a method to achieve lean objective are:

- Coordinating the tasks of different subcontractors such as mechanical, electrical and plumbing (Clayton et al, 2002)
- helping both sectors, owners and contractors understand how a facility will be constructed over time (Koo et al, 2000)
- helping contractors and sub-contractors to effectively communicate the overall sequencing and logistics of the project during the design phase (Heesom et al, 2004)
- Analyzing constructability of different construction methods and selecting the best one by considering customers’ needs and value (Akinci et al , 2002)
- Forecasting of time-space conflicts or constraints during the total project duration (Haymaker et al, 2001)
- Using the previous similar models for the best estimation of time and quantity as well as eliminating waste and conflicts observed from previous projects (Staub-French et al, 2003)
Kaizen: It can be argued that most of the tools are used in lean to achieve Kaizen, or continuous improvement. Kaizen can help projects to achieve higher quality, better maintenance, improved cost reduction, and increased safety. The benefit of implementing Kaizen is not solely presenting innovative ideas by employees, but the learning process that they experience in Kaizen. The PDCA (plan, do, check, and act) is the best technique that can be used for implementing Kaizen (Salem, Solomon, Genaidy, & Minkarah, 2006).

Root Cause Analysis (RCA): RCA is the process to identify, solve, and prevent the main cause of problems in the construction industry. In the identification phase, the cause is found by implementing some popular approaches like the cause and effect diagram (CED), why-why analysis (five whys), tree diagram, Apollo root cause analysis (ARCA), and Kepner-Tregoe (K-T). (Sarkar, Mukhopadhyay, & Ghosh, 2013)

Consequently, all definitions and explanations provided for lean construction can be summarized as any tools or principles that help a project to achieve the following items:

- Add more value to the needs of suppliers, stakeholders, DOTs, employees, unions, shareholders, and end-users, which is considered as lean enterprise, by eliminating waste, improving quality, and best responding to their needs
- Increase schedule reliability by eliminating non-value added activities and implementing the Last Planner System
- Accelerate the learning curve both by providing a continuous evolution training environment and by practicing an error-free project by finding previous errors and their origins and investigating solutions to stop repeating them
- Increase transparent communication skills among subcontractors, contractors, owners, and stakeholders
Generally, this means that in order to achieve lean objectives, eliminate waste and add value to customers’ needs, lean principles are implemented. However, for implementing those five principles mentioned on the literature review, lean tools should be implemented. Lean tools can be any method, way, idea, or software program that can help to achieve lean principles and consequently lean thinking. Figure 2 shows how these items are related to each other.

![Figure 2: Lean structure](image)

**Why Lean Can Be Helpful in PPP**

The most crucial common variables between PPPs and lean are duration and time (Parnell-Klabo, 2006) which means long-term period is needed to get the best results from implementing lean. Therefore, PPPs can be the best fit to provide this prerequisite since the commitment of the contract can be as long as 99 years, like in Virginia Department of Transportation in Pocahontas 895.

Consequently, with all this research being conducted on lean, its definition, and its advantages in the construction industry, this study aims to investigate if state DOTs are realizing the potential benefits of applying lean principles in PPP project through the selection of lean qualified contractors.
Applying lean principles has been proven to provide major opportunities, not only in manufacturing, but also in the construction industry. A US Government case study has proven that the construction industry wastes $15.8 billion each year (Gallaher et al., 2004). Thus, requesting the proposers to have lean experience and be familiar with lean constructions can help both the private and public sectors achieve their long term project goals with minimum waste. The main advantage of lean production principles as pointed out by Lapinski et al. (2007) is that they have been proven to decrease waste and increase efficiency in exceedingly complex development and production environments. Providing services in PPPs can be considered as production environments in manufacturing since in all definitions providing services is one of the main characteristics of PPPs. In addition, complexity of PPPs is another factor in which lean can be a great tool to be implemented to decrease the risks. However, as Alves (2012) and Pettersen (2009) put it, lean construction has different definitions which are caused by not having unanimous meaning for lean principles. Although finding a unanimous definition for lean, which can cover all lean principles, is an intimidating challenge, one potential impact relates to how owners, who hire services related to the construction industry, understand lean construction, and how they can distinguish between firms who truly invest in implementing lean applications from those who use it as part of their marketing promotion or adopt it in a very narrow perspective (Green & May 2005; Alves 2012).

Consequently, duration and integration aspects of PPP procurement make PPP projects so unique. The long duration brings more risks and uncertainty for both parties, DOTs and contractors, and integration force them to respond to each other’s interests. In this regard, lean, which has been proven as integrated application (Hassan 2013; Pepper & Spedding 2010), can
decrease both parties’ risks and uncertainty. This research aims to investigate how important lean was in PPP projects from the DOTs’ and project managers’ perspectives.
CHAPTER III: METHODOLOGY

Before selecting a proper research methodology, it is crucial to determine the research topic, objectives, and questions. The topic of this research is lean application in highway PPP project bid documents; more specifically, investigating the importance of lean as one of the evaluation criteria in PPP procurement from DOTs and project managers’ perspective. However, as discussed above, having the correct understanding of lean was of utmost importance for this research. Therefore, in order to be able to achieve the main aim of this study, responding to the following questions could lay the foundation for answering the main objective:

1. How many DOTs are currently using lean as one of the evaluation criteria in the bidding process?
2. How much weight do DOTs allocate to lean in evaluating proposals?
3. What is the definition and what are the advantages of lean and lean principles?
4. How is lean addressed as an evaluation criterion in RFP and how can it be addressed by contractors in their proposals?

Surveys, experiments, ethnographic observations, and unobtrusive techniques are all different research methods that depend on perspectives of a research question. Each has its specific problems of validity, reliability, and limits to perform (Abowitz & Toole, 2010). This study used a mixed research method in order to find answers for the above research questions. The definition of each method, reasons for selecting the methods, and the process of each method will be discussed below.

Mixed Research Methods

Mixed methods are used to connect or integrate the qualitative and quantitative methods in order to test different approaches for two or more data collections. A mixed method can
increase validity and reliability in comparison with single method. Mixed methods are categorized into three general tactics:

1. Sequential mixed methods: Expanding the findings of one method with another method.

2. Concurrent mixed methods: Providing a comprehensive analysis of the problem in question. The data is collected from both methods simultaneously and then compiles all the results.

3. Transformative mixed methods: Addressing change at levels ranging from the personal to the political (Creswell 2009).

This research involved the use of concurrent mixed methods employing both a qualitative and a quantitative research method to investigate how important lean was in PPP projects from the DOTs’ and project managers’ perspectives. The qualitative study was conducted to get other sectors’ ideas, private sectors, about implementing lean and its importance in PPP projects.

The following sections discuss the methods that will be employed in this study in more detail. Before starting the quantitative and qualitative study, it was important to have a thorough understanding of the problem in question. Therefore, in order to analyze the results from the interviews and validate it, the author tried to find different scholars’ ideas on lean, lean principles and lean tools through a review of relevant literature. This was of utmost importance in this study since no unanimous definition for lean was found in the literature. Figure 3 shows the overall research design for this study:
Figure 3: Overall research design

Quantitative Study

Quantitative research focuses on testing a hypothesis or a theory proposed. This kind of research focuses on variables which are measured with numbers and analyzed using statistical process. Quantitative study is preferred when researching a fact about a concept or a question by collecting factual evidence and studying the correlations between these facts (Naoum, 2007).

There are two main quantitative research methods:
Experimental designs: This method indicates if specific inputs impact the output.

Surveys: They are used to present a numeric description of the opinions or trends of a population by studying a sample size of that population. (Creswell 2009; Robson, 2002).

Surveys

Since experiments were inapplicable to this study, surveys were employed. The surveys targeted the whole population, 33 states which already have PPP legislation based on FHWA (2013). As Oppenheim (1966) puts it, reaching to the whole population in a survey makes it the best method to be used. The questions driving this preliminary survey were:

1. Does state DOTs consider lean application as one of the bidders’ qualifications criteria in PPP projects?
2. How much weight do DOTs allocate to lean in evaluating proposals?

The preliminary survey was administered via e-mail and targeted procurement personnel employed in the 33 state DOTs. Contacts of the procurement personnel were obtained using DOTs’ websites. The surveys were sent in three waves; first an email with the survey questions was sent to the 33 State DOT potential participants, followed by two reminder e-mails to non-respondents. The first reminder e-mail was sent after three days, followed by the second reminder after ten days. Lean definition, principles, and tools were provided if the state DOTs asked for further verification of lean meaning.

Qualitative Study

Qualitative research tries to investigate attitudes, behaviors, meanings, and experiences through collecting in-depth idea from fewer respondents in comparison with quantitate study (Dawson, 2002). Examples of qualitative research methods include:
• Narrative Research: The researcher studies the lives of individuals through the participants’ narration of their life stories.

• Phenomenology: The researcher identifies the essence of human experience towards a phenomenon as described by the participants.

• Ethnographies: The researcher studies a cultural group in the actual setting through a long period of time.

• Grounded theory studies: The researcher proposes a theory based on the views of the participants.

• Case study: The researcher explores in detail a project, process, or event (Creswell, 2009).

Interviews

The main objective of using interviews was to get the expert people’s experience regarding implementing lean, lean principles, and lean tools. There are different views on the number of interviews to be conducted. Bertaux (1981) claimed that fifteen is the minimum adequate sample size in qualitative research. However, Morse (1994) recommended at least six participants for phenomenological studies, which study a phenomena as experienced from the first-person point of view. On the other hand, Creswell’s (1998) suggested between five and twenty-five interviews for phenomenological studies. Nielsen and Landauer (1993) argued that six interviews can uncover 80% of the major usability problems within a system, and twelve participants can uncover 90%. Guest (2006) had an amazing study to identify the best number of interviews. Among 60 interviews, he found 34 different codes. Interestingly, he mentioned that 94% of the codes had already been identified within the first six interviews and 97% after 12 interviews. In this study, seventeen project managers with at least five year experience in PPP
projects as well as two year experience in lean were contacted to get their opinions regarding lean definition and its importance in PPP projects. Six of them consented to participate in the study. A sample of six interviews as per Morse (1994) and Creswell (1998) is sufficient to get conclusion about the interviewees’ experience about a phenomena.

There are three essential types of research interviews: structured, semi-structured, and unstructured. In structured interview, a list of predetermined questions is asked, with little or no variation and with no scope for follow-up questions to responses. However, by their very nature, they only allow for limited participant responses. Semi-structured interviews consist of several key questions that help to define the areas to be explored, but also allow the interviewer or interviewee to diverge in order to pursue an idea or response in more detail. Conversely, unstructured interviews do not reflect any preconceived theories or ideas and are performed with little or no organization (Gill, Stewart, Treasure, & Chadwick, 2008). To allow the interviewer, as well as the interviewee the option to explore certain ideas more during the interview, this study conducted semi-structured interviews. The list of the main questions asked in the interviews are included in Appendix A.

In order to contact the potential project managers, different resources were investigated. Linkedin and companies’ websites that participated in PPP projects were reviewed. An email with the purpose of the study and the list of the questions were sent to the potential project managers, and they were asked if they were willing to participate in a one hour phone interview. Once they agreed, the time for the interview was set based on their convenience. After contacting them via phone, all of them were again informed about the purpose of the research and their willingness. Next, each question was asked accordingly and a few follow-up questions were
asked based on the interviewees’ responses. The interviewees were project managers that met the following criteria:

- Have at least five years of experience in highway PPP projects in the United States
- Have at least two years of experience in lean application in PPP projects

Conclusions

This study employed a concurrent mixed research methodology that involved both surveys and interviews. Surveys targeted the 33 DOTs with PPP legislation to investigate if they use lean as an evaluation criterion. Interviews aimed at obtaining project managers’ feedback on lean and implementing lean in PPP projects and targeted project managers with experience in both PPP projects and lean.
CHAPTER IV: FINDINGS

After conducting the survey and the interviews, the results were gathered and analyzed. The data was investigated for significance in order to respond to the objective of this study. Below are following sections: Response rates, survey results, and interview results.

Response Rates

The survey was administered via e-mail and targeted procurement personnel employed in the 33 state Departments of Transportation (DOTs) with PPP legislation. At the end, the response rate was 42% (14 out of 33 State DOTs responded) which - based on Baruch's (1999) percentage of 36.1% response rate- is acceptable for online survey about management and organizational representatives. The responded states were Arkansas, Colorado, Connecticut, Delaware, Florida, Louisiana, Mississippi, Missouri, Nevada, North Carolina, North Dakota, Ohio, Oregon, and Tennessee.

For conducting the interviews, the criteria of five year experience in Public-Private Partnerships (PPPs) and two year experience in lean made the sample smaller than what was originally assumed. Seventeen project managers who met those criteria were contacted out of which six were willing to have the interview.

Table 2 shows the interviewees’ experience in different areas:
Table 2: Interviewees’ experience in the construction industry, PPP, and lean

<table>
<thead>
<tr>
<th>Interviewees</th>
<th>Construction experience (years)</th>
<th>PPP experience (years)</th>
<th>Lean experience (years)</th>
<th>Lean Certified</th>
<th>Implementing lean in projects*</th>
<th>Implementing lean in office**</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>32</td>
<td>6</td>
<td>2</td>
<td>X</td>
<td>√</td>
<td>X</td>
</tr>
<tr>
<td>B</td>
<td>40</td>
<td>8</td>
<td>3</td>
<td>X</td>
<td>√</td>
<td>X</td>
</tr>
<tr>
<td>C</td>
<td>10</td>
<td>5</td>
<td>4</td>
<td>X</td>
<td>√</td>
<td>X</td>
</tr>
<tr>
<td>D</td>
<td>22</td>
<td>18</td>
<td>4</td>
<td>X</td>
<td>√</td>
<td>X</td>
</tr>
<tr>
<td>E</td>
<td>35</td>
<td>5</td>
<td>8</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
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<td>F</td>
<td>18</td>
<td>7</td>
<td>4</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

*Refers to project managers who indicated their experience in implementing lean in construction project sites

**Refers to project managers who indicated their experience in implementing lean in the company’s office building

Results

Survey

Based on the survey responses, six state DOTs (out of the 14) neither have experience in PPPs projects nor have they established an evaluation criteria framework. Eight state DOTs, on the other hand, have either experience in PPPs or they have an established evaluation criteria framework for selecting contractors.

After analyzing the 14 respondents recorded, some unexpected results were found. Although it was assumed, at the beginning of the study, that some DOTs may not have started procuring PPPs projects, it was assumed that DOTs with PPP allowing legislations would have at least an established framework and guidelines used for evaluation criteria. The assumption of this paper was challenged by finding that 43% of the responding DOTs (6 out of 14) of the states neither have experienced PPPs nor have they established framework used for evaluation criteria.

Based on this finding, two groups of DOTs, with PPP legislations, were classified. Table 3 shows the state DOTs in each group.
• **Group 1**: Inexperienced DOTs that have not employed PPP and no evaluation criteria established for PPP procurement

• **Group 2**: Experienced DOTs that have PPP projects or have an established evaluation criteria in PPP procurement

<table>
<thead>
<tr>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arkansas</td>
<td>Colorado</td>
</tr>
<tr>
<td>Delaware</td>
<td>Connecticut</td>
</tr>
<tr>
<td>North Dakota</td>
<td>Florida</td>
</tr>
<tr>
<td>Louisiana</td>
<td>Mississippi</td>
</tr>
<tr>
<td>Oregon</td>
<td>Missouri</td>
</tr>
<tr>
<td>Tennessee</td>
<td>Nevada</td>
</tr>
<tr>
<td></td>
<td>North Carolina</td>
</tr>
<tr>
<td></td>
<td>Ohio</td>
</tr>
</tbody>
</table>

Since question two required DOTs to have experience or have established evaluation criteria in PPP, only state DOTs in “Group 2” were qualified to answer the questions provided in this survey. Interestingly, the result drawn from the literature review about not having unanimous definition about lean was raised again and confirmed through the responses of the survey participants. Three out of eight states asked for a definition and clarification about the meaning of lean. Therefore, based on states DOTs reported familiarity with lean, “Group 2” was categorized into two subcategories on table 4:

• **Group 2.A**: State DOTs which reported non-familiarity with the term “lean” and requested further definitions/clarifications

• **Group 2.B**: State DOTs which reported familiarity with lean applications
Table 4: State DOTs grouped by their reported familiarity with lean applications

<table>
<thead>
<tr>
<th>Group 2.A</th>
<th>Group 2.B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colorado</td>
<td>Connecticut</td>
</tr>
<tr>
<td>Florida</td>
<td>Mississippi</td>
</tr>
<tr>
<td>Nevada</td>
<td>Missouri</td>
</tr>
<tr>
<td></td>
<td>North Carolina</td>
</tr>
<tr>
<td></td>
<td>Ohio</td>
</tr>
</tbody>
</table>

Figure 4 summarizes the results of the survey based on the group categorization developed. This result shows that 43% of state DOTs neither have used PPP nor have established a framework for evaluation criteria (6 out of 14). On the other hand, the rest of state DOTs, 57% of respondents, have either used PPPs or established evaluation criteria framework (8 out of 14). Within this group, 37% state DOTs (3 out of 8) were unfamiliar with lean definition and asked for clarification. However, 63% state DOTs (5 out of 8) were familiar with lean concept and responded to the first question based on their understanding of lean. The five state DOTs that indicated familiarity with lean applications reported that they do not consider lean as one of the evaluation criteria in PPP bid documents. It was, thus, concluded, based on the survey responses, that even states that use PPPs and are familiar with lean concepts are not incorporating them in their bid documents as an evaluation criterion.

Figure 4: Population result based on using PPP and familiarity of term “lean”
It is worth mentioning that although all DOTs who responded did not directly report lean as one of the evaluation criteria, some had partially included lean concept in their RFP documents. For example, contractors’ plans for making improvement to the project and how contractors would implement more innovation into the projects has been asked by the state DOTs that have had experience in PPP projects.

Interviews

Six project managers that were willing to have an interview were contacted. A one hour phone interview was conducted with each of them to get into more depth about their opinion about lean principles and its advantages in PPP projects. Their ideas were investigated in five main categories as follows:

1. Lean as a new strategy:

On the first interview, a new topic was mentioned by the interviewee. Although interviewee A agreed that the lean strategy can help the construction industry, he argued that lean strategy had been used before these principles were presented to the manufacturing and construction industries; “I would see lean as more academic label, we were using lean strategy before. The only difference might be it is now just more structured and organized way of how to do the work”. He claimed that 80% of the lean strategy has been used before. The same question was asked to the other interviewees to see if they saw lean as an academic label. The higher percentage means that the interviewee agreed with lean as a new strategy with new principles that had not been used before. The lower percentage indicated that the interviewee believed the lean concept had been implemented before, and project managers had used lean principles; nevertheless, those principles had not introduced to the construction industry. The interviewees’ responses to this question are shown on table 5.
Table 5: Percentage of new lean strategy

<table>
<thead>
<tr>
<th>Interviewees</th>
<th>percentage of new lean strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>20%</td>
</tr>
<tr>
<td>B</td>
<td>40%</td>
</tr>
<tr>
<td>C</td>
<td>30%</td>
</tr>
<tr>
<td>D</td>
<td>25%</td>
</tr>
<tr>
<td>E</td>
<td>80%</td>
</tr>
<tr>
<td>F</td>
<td>60%</td>
</tr>
</tbody>
</table>

The result from the interviewees’ perspectives about what percentage of lean strategy is new and how much of it was being used before shows an interesting observation. The interviewees who allocated less than 50%, the first four interviewees, did not have a lean certification. However, interviewees E and F had their certification from The Associated of General Contractors (AGC) of America. It would be interesting to investigate if being certified in lean can change project managers’ perspectives about lean principles.

2. Lean definition

Based on the findings from the literature review about a unanimous lean definition, the interviewees were asked to provide their definition about lean. Although the definition provided by each interviewee was slightly different than others and encompassing all of their definitions into one solid definition is hardly possible, the following characteristics of lean were emphasized by all of them:

- A strategy and philosophy to make and continue improvement
- Adding more value to customers’ needs
- Eliminating waste
- Reducing cost
- Working more efficiently
The reason why no solid definition could be found for lean in either the literature review or interviews is mainly because of its characteristics. Lean tries to make improvement, but how this improvement can be defined and applied make people’s perspectives different about lean. In addition, the last four characteristics provided above can be a subcategory of the first one. The last four characteristics exist because of people’s idea about improvement. Some project managers’ priority is to see less waste, some want to see more productive employees, while some try to increase customers’ satisfaction. For example, interviewee B argued that not using all the features of a software program can be considered waste from his perspective. In addition, interviewee C mentioned that hiring an overqualified employee is a kind of waste. However, he added that nowadays people who are going to be hired can hardly have the same level of qualification that the firms are looking for. Therefore, the most inclusive and simplest definition for lean can be structured continuous improvement. The argument that may be raised is that all firms trying to improve in some aspects are realistically doing lean. The answer is “no”. The continuous improvements that lean can bring to a firm are fast, organized and structured, and innovative; mainly setting up a structured framework by which improvements can be implemented.

3. Lean tools

All the interviewees concurred that there are some tools which can be implemented in the construction industry as well as the manufacturing industry. However, they argued that implementing a specific lean tool cannot be determined or related to the PDM. The lean tools that can be more beneficial in the construction industry based on the interviewees’ opinions are as follows:

• 5s
- Root cause analysis
- Value stream map
- Pull planning/ Last planner system
- Kaizen

Although the interviewees believed that implementing these tools can be helpful in all PDMs, they agreed that the length of the contracts can make those tools more valuable and beneficial for both contractors and clients. All interviewees mentioned the importance of lean principles in a long term contract such as PPP.

They also mentioned that implementing 5s can help have a more organized project site and decrease the waste. In addition, 5s can help contractors to design, construct, operate, and maintain projects with higher quality than required by structure and safety codes. However, when the interviewees were asked if they implemented lean in their office as well as the job site, only the last two lean certified interviewees consented. Therefore, it can be argued that among these six interviewees’ companies, implementing lean was usually limited to the project sites; the contractors were missing the opportunity to implement lean in their offices.

Root cause analysis was another common lean tool that was mentioned by the interviewees. They all mentioned that this tool can prevent them from having a repetitive problem. Also, interviewee F emphasized the importance of this tool in PPP by saying: “*In a long term contract, having an organized way of root cause analysis can tremendously decrease facing repetitive problems*”.

Although all the interviewees mentioned the value stream map as one of the most common lean tools to highlight the opportunities to improve the construction, operation, and
maintenance of projects, Interviewee E mentioned his experience in effectively implementing the value stream map in PPP projects by using Virtual Design and Construction (VDC).

Pull planning, more specifically the Last Planner System (LPSt), was introduced as another common lean tool that all interviewees implemented in their PPP projects. However, interviewee E argued that the LPSt cannot be a good fit for the construction industry due to adding more variables and assumptions to the schedules. He mentioned that implementing the LPSt in the construction industry needs promised and well-trained subcontractors; also there are more risks in the construction industries that may increase the assumptions in the LPSt like if weather conditions do not let the subcontractors get their job done on time. Therefore, he stated that although they implemented LPSt in most of their work, he personally believed that it is too soon for the construction industry to rely on this tool.

Finally, Kaizen was mentioned by the interviewees as a tool to implement the employees’ innovations to make continuous improvement situations. They all mentioned that the prerequisite for correctly implementing this tool is highly educated and trained employees.

4. Risks:

All the interviewees agreed that implementing lean can help to decrease the levels of risks in PPP projects. The most common risks addressed by the interviewees were related to the risks that are associated with the project life cycle and not only the design phase or construction phase:

- Project and operation changes
- Operation and maintenance cost overruns

These two risks were emphasized by all interviewees. It is obvious that both of these risks are exactly associated with the main characteristics of PPP projects. Operating and maintaining
parts make PPP and its risks different than other PDMs. All the interviewees mentioned that by implementing the lean tools that were mentioned above, contractors would be able to reduce the number of changes and exactly track each activity during the operation and maintenance phase and compare that with their value of money analysis. Also contractors would be able to implement “root cause analysis” to find the main problem and stop it from occurring again.

Although all of the interviewees mentioned the first two risks that can be reduced by implementing lean tools, interviewee D emphasized that in order to successfully reduce the level of those risks, it is of crucial importance that all parties have lean experience: owners, general contractors, and subcontractors. He argued that “When we do root cause analysis, we realize that the cause of some problems are not us or we cannot solve it without DOTs’ help”. However, if DOTs implement lean and they try to use “root cause analysis”, they can solve these problems. He believed that the key of success in implementing lean in PPP projects is DOTs. “If they implement lean in their office, if they train their employees about lean principles and how they can be a lean thinker, PPP will be more successful.” He mentioned that this way not only DOTs can implement lean and its advantages, but also they can be more experienced in distinguishing the lean experienced contractors and non-lean experienced ones. He stated that in a lean firm, all employees should be trained about lean. Otherwise, they will see the principles as a waste of time. He added that this can be exactly the same situation when the other parties are not trained about lean. Training the DOTs’ employees can result in being more lean thinkers and unaffected by political decisions, which happen a lot in PPP projects. Instead, by having lean experienced DOTs, the added value would be distributed to all three parties: DOTs, end users, and contractors.

5. Hiring contractors
All the interviewees agreed that awarding a PPP project to a lean experience firm can result in more satisfied end users and DOTs. However, they mentioned that although they have faced lean as one of the evaluation criteria in RFP in most of IPD projects like design build recently, they have not seen a direct question asking about lean experience in RFP in PPP projects.

However, interviewees A, D, E, and F believed that there are questions regarding being more innovative, cost efficient, and making more improvements that many companies respond to by mentioning their experience in Leadership in Energy and Environmental Design (LEED), Building Information Modeling (BIM), and lean.

Although all the interviewees believed that both addressing lean experience by contractors and evaluating this by DOT’s can be hard, the following suggestions were provided for demonstrating PPP contractors and appropriately evaluating them in RFP:

- Provide documents regarding the lean training of all employees and the number of lean certified employees.
- Ask the previous clients of the contractors what repetitive problems they had faced in their previous jobs and why the company could not root cause those issues in order to stop them from happening again.
- Provide documentation of the company’s innovation to make more productive employees both at the office and job site.

Interviewee E gave an example that can be used to easily evaluate “root cause analysis.” He emphasized that although currently not all the lean objectives, an error free environment with high innovations and productions, in the construction industry can completely be met, lean implementation can prevent repeating the same problem. Therefore, firms can continuously
improve and get closer to an error free environment with higher quality and better innovations.

“When you make the same mistake as you did a year ago, how can you consider yourself or your firm as lean experienced” interviewee E argued. There were three main subjects that all of the interviewees focused on as supporting materials for being lean experienced: training the employees, not having repetitive problems, and making continuous improvements through the project life cycle. They argued that the main difficulties to support lean experience come from the second and third categories: proving not to have repetitive problems and supporting their continuous improvements on previous jobs and their plans for the future jobs.

In this chapter, the results of the survey and interviews were presented. Among the 14 respondents recorded for the survey, 43% of state DOTs neither have used PPP procurements nor have established a framework for evaluation criteria. On the other hand, the rest of state DOTs, 57% of respondents, have either used PPP procurements or established evaluation criteria framework. Within the latter group, 37% of them were unfamiliar with lean definition, and 63% were familiar with lean. The five state DOTs that indicated familiarity with lean applications reported that they did not consider lean as one of the evaluation criteria in PPP bid documents. It was concluded that even the states that used PPPs and were familiar with lean concepts were not incorporating them in their bid documents as an evaluation criterion.

On the other side, from the interview with six project managers, it was concluded that two project managers that had lean certification allocated more value to lean as a new and unique strategy which had not been used before. In addition, based on all interviewees’ opinions lean was defined as *structured continuous improvement*. Furthermore, the most helpful lean tools in the construction industry were mentioned: 5s, root cause analysis, value stream map, pull planning (last planner system), and Kaizen. More importantly, the interviewees indicated that
implementing lean in PPP projects can help to assess two significant risks related to the
operation and maintenance phases: Project and operation changes and operation and maintenance
cost overruns. Moreover, suggestions regarding how lean experience can be addressed in RFPs
were provided to help contractors supports their lean experience. Also, these suggestions can
help owners, public sectors, to easily distinguish between the firms that present their lean
experience as a marketing tool, and the firms that are really familiar and implement lean in their
jobs.
CHAPTER V: CONCLUSIONS AND RECOMMENDATIONS

Public Private Partnership projects have proven to realize successful project within budget and schedule and with high quality. However, many scholars as discussed previously in the literature reported that PPP projects still face many challenges compared to other PDMs especially with its long concession period in which operation and maintenance should be done by the contractor/private party. As mentioned in the literature review, the result of implementing lean in Design-Bid-Build, Design Build, and IPD projects has shown significant advantages in adding more value to the projects and clients by responding to exact customers’ needs, eliminating waste, improving quality, accelerating the schedule by eliminating non-value added activities, accelerating learning curve, and boosting transparency within communication. Though lean application has been studied in various forms of PDM, there was no research done investigating the potential benefits a concept like lean could bring PPP projects characterized by long-term involvement of the private sector. This study, thus, aimed at investigating if lean has been applied in PPP projects and the benefits it has added to the PPP projects. To address this issue, it was appropriate to question what lean meant for PPP parties, whether the contractors working on such projects are evaluated for their lean experience during the selection process, and the benefits realized from lean principles application in PPP projects.

To answer those questions, the study utilized both surveys and interviews. As for the survey administered to state DOTs who have PPP legislations (33 DOTs) that aimed at investigating DOT’s emphasis on lean’s importance in RFPs/RFQs and determine if it is incorporated as one of the evaluation criteria in RFQ/RFP documents. Survey results showed that out of 14 respondents, none of them has used lean as one of the evaluation criteria in PPP bidding documents. Moreover, 43% of the state DOTs which have PPP legislations have not
employed this kind of PDM and do not have an established framework for the evaluation criteria. On the other side, 37% of DOTs which either have used PPP or have an established framework for evaluation criteria are not familiar with the lean definition. All state DOTs who reported familiarity with lean principles do not consider lean as an evaluation criteria in RFP or RFQ in PPP procurement.

Though the research drive started from investigating whether state DOTs include lean principles as one of the evaluation criteria in their bid documents, the question brought a more interesting finding: a significant percentage of the survey respondents reported non-familiarity with term “lean”. However, as discussed in the previous chapter, few state DOTs’ documents were found that implicitly asked for some criteria which represented lean definition: *structured continuous improvement*. For example, in an RFP provided by Colorado DOT (2013) for the “US 36 phase 2 corridor,” under the section of “Technical Proposal Qualitative Criteria,” one of the evaluation criteria was mentioned as follows: “The effectiveness of the quality approach to plan and implement the monitoring, measurement, analysis, and improvement process to continually improve the quality program” (p. 34). Therefore, the conclusion could be drawn that the survey study results showed unfamiliarity of state DOTs with the word “lean” and not with the lean principles’ underlying application.

Interviews were conducted with six project managers who have experience in both PPP projects and lean. The following conclusions were drawn from the interviews conducted:

- Results from both the interviews and the literature review conducted showed that lean could be defined lean as “*structured continuous improvement*”.
- Lean, in its underlying application, was not seen by most interviewees as a new strategy though the two interviewees with lean certification did see it as a new strategy
There was an agreement among the interviewees that lean tools are irrespective of the kind of PDMs used in the project. The most recommended tools they mentioned were 5S, Kaizen, root cause analysis, value stream map, and pull planning.

Lean application was seen as very significant in PPP projects in mitigating two types of risks associated with the long term concession of PPP projects; “project and operation changes” and “operation and maintenance cost overruns.”

Though all interviewees reported not seeing a direct questions regarding lean qualification in RFPs, four of them believed that there were implicit questions in the RFPs that do address lean applications such as innovation, cost efficiency, and improvements. They also provided some suggestions on how lean experience can be properly evaluated rather that mentioning it as a marketing advertisement strategy in responding to RFPs.

In conclusion, selecting a contractor with experience in lean means that all the members of the company are familiar with lean thinking (LT) and the company is continuously improving its functions at both its home office and project site. Also, contractors’ responses to lean experience can be evaluated based on the suggestions provided in this study. Selecting such a company for PPP projects can thus help both sectors decrease the risks and prevent renegotiation, eliminate waste, and accordingly increase the quality of the facility. Thus, having lean experience as one of the evaluation criteria to select the proper bidder can potentially play a significant role in the success of PPP projects.

Recommendations for Procuring PPP Projects

Based on the conclusions drawn, the following recommendations for procuring PPP projects are presented:
• Developing a consistent definition for lean application in RFP/RFQ documents that includes all the aspects of lean application in construction such as how each lean tool will be implemented

• Promoting the application of lean not necessarily as a word but as a concept

Recommendations for Future Studies

Based on the conclusions drawn, the following recommendations for future studies are presented:

• Studying proper weight for lean criteria in evaluation proposals if state DOTs are to start requesting lean qualifications in their bidding documents

• Investigating the benefits of implementing lean Six Sigma

• Exploring case studies of specific PPP projects to explore how lean applications in such projects could add value to the owner and the public

• Conducting research with certified lean project managers to get better perspectives about how lean certifications can change managers’ perspectives about the new strategies in lean and improve lean implementation in construction projects
BIBLIOGRAPHY


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## APPENDIX A: INTERVIEW QUESTIONNAIRE

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<thead>
<tr>
<th>No</th>
<th>Interview Questions</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction about yourself, your name, how many years of experience, which companies have you worked with, which states.</td>
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<tr>
<td>2</td>
<td>What do you know about lean? What's your definition/understanding of lean principles?</td>
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<tr>
<td>3</td>
<td>How important do you think lean can be? How much of lean principles has been used before? What value does it add? How is changing the way you do operate now?</td>
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<tr>
<td>4</td>
<td>Why lean can be more important in construction industry?</td>
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<tr>
<td>5</td>
<td>Does your company apply lean principles? For how many years have you been applying lean in your company? If yes, questions 6.</td>
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<tr>
<td>6</td>
<td>What was the drive for applying lean principles? In which areas? (office operations, engr, construction, …)</td>
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<tr>
<td>7</td>
<td>How your company apply lean? Provide specific examples</td>
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<tr>
<td>8</td>
<td>What lean principles are you familiar with?</td>
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<tr>
<td>9</td>
<td>What lean principles can be more useful in construction industry? Why?</td>
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<tr>
<td>10</td>
<td>Have you used or heard of any software that can help a company to develop lean? What software? How it can help each lean principle?</td>
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<tr>
<td>11</td>
<td>Are you familiar with certification of lean that could be obtained? Name it. Does it add any value to the company/personnel?</td>
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<tr>
<td>12</td>
<td>Do you believe that lean should be part of the Request for Proposal to evaluate contractors?</td>
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<tr>
<td>13</td>
<td>In any kind of Request for Proposal, have you seen the owner requesting the contractor to address their experience in lean? If yes, questions 14 to 17.</td>
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<tr>
<td>14</td>
<td>What type of project? What size? Public/private?</td>
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<tr>
<td>15</td>
<td>How owner addressed lean in their Request for Proposal?</td>
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<tr>
<td>16</td>
<td>Did they specify any lean principles in their request?</td>
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<tr>
<td>17</td>
<td>How did you address their request about lean, what do you provide in your proposal to support lean experience? Could you send the document of your proposal to me?</td>
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<tr>
<td>18</td>
<td>Do you think that lean can be addressed in proposal in a way that owners can evaluate it?</td>
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<tr>
<td>19</td>
<td>Do you have any suggestion to address lean better in proposals?</td>
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<tr>
<td>20</td>
<td>Do you believe that addressing lean can be different from one project delivery method to the other one (Is it based on kind of project delivery method)?</td>
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<tr>
<td>21</td>
<td>What do you know about Public Private Partnership? Have you ever worked in a project with PPP delivery method? Which projects?</td>
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<tr>
<td>22</td>
<td>What crucial differences do you see between PPP and other kind of project delivery methods?</td>
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<tr>
<td>23</td>
<td>Do you think that lean is more important in PPP than any other project delivery methods? If yes, why?</td>
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<tr>
<td>24</td>
<td>How and why do you think lean principles can be helpful in PPP? What differences do you see in PPP that require more attention for lean?</td>
</tr>
<tr>
<td>25</td>
<td>Which lean principles can be more beneficial in PPP? Why?</td>
</tr>
<tr>
<td>26</td>
<td>How do you think a company can address lean in their proposal for PPP projects in order to satisfy PPP differences from other project delivery methods?</td>
</tr>
<tr>
<td>27</td>
<td>What do you think are (have been) the major challenges in addressing lean principles in your proposals?</td>
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APPENDIX B: HSRB APPROVAL LETTER

BGSU
BOWLING GREEN STATE UNIVERSITY
Office of Research Compliance

DATE: February 7, 2014
TO: Ramtin Malek, Master’s
FROM: Bowling Green State University Human Subjects Review Board

PROJECT TITLE: [542100-3] LEAN PRINCIPLES APPLICATION IN PUBLIC-PRIVATE PARTNERSHIP PROJECT PROCUREMENT
SUBMISSION TYPE: Revision

ACTION: APPROVED
APPROVAL DATE: February 7, 2014
EXPIRATION DATE: January 17, 2015
REVIEW TYPE: Expedited Review

REVIEW CATEGORY: Expedited review category # 7

Thank you for your submission of Revision materials for this project. The Bowling Green State University Human Subjects Review Board has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

The final approved version of the consent document(s) is available as a published Board Document in the Review Details page. You must use the approved version of the consent document when obtaining consent from participants. Informed consent must continue throughout the project via a dialogue between the researcher and research participant. Federal regulations require that each participant receives a copy of the consent document.

Please add the text equivalent of the HSRB IRBNet approval/expiration date stamp to the "footer" area of the electronic consent document.

Please note that you are responsible to conduct the study as approved by the HSRB. If you seek to make any changes in your project activities or procedures, those modifications must be approved by this committee prior to initiation. Please use the modification request form for this procedure.

You have been approved to enroll 43 participants. If you wish to enroll additional participants you must seek approval from the HSRB.

ALL UNANTICIPATED PROBLEMS involving risks to subjects or others and SERIOUS and UNEXPECTED adverse events must be reported promptly to this office. All NON-COMPLIANCE issues or COMPLAINTS regarding this project must also be reported promptly to this office.

This approval expires on January 17, 2015. You will receive a continuing review notice before your project expires. If you wish to continue your work after the expiration date, your documentation for continuing review must be received with sufficient time for review and continued approval before the expiration date.

Good luck with your work. If you have any questions, please contact the Office of Research Compliance at 419-372-7716 or hsr@bgsu.edu. Please include your project title and reference number in all correspondence regarding this project.
This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Bowling Green State University Human Subjects Review Board's records.
APPENDIX C: INTERVIEW CONSENT LETTER

Informed consent for participating as an interviewee for the study of lean principles application in public-private partnership project procurement

Introduction: My name is Kaitlin Malek, a graduate student from the Department of Construction Management at Bowling Green State University. I would like to invite you to participate in my research study to investigate LEAN PRINCIPLES APPLICATION IN PUBLIC-PRIVATE PARTNERSHIP PROJECT PROCUREMENT. You are selected to participate in this study because you have more than five-year experience in the construction industry and PPP projects in addition to having two year experience in lean.

Purpose: The goal of this study is helping both Departments of Transportation and construction firms to have the same knowledge about lean principles and its advantages in order to construct more high-quality highways with less money in a shorter time. This research will investigate how the lean principles are addressed on your proposals for awarding PPP projects from department of transportation. This research will help Departments of Transportation to procure more PPP projects which will result in paying less tax for constructing highways from you, all end users, citizens, and residents. You as a resident will be able to use more highways which would not have been possible to be constructed with traditional project delivery methods such as design-bid-build.

As a participant, you will be asked to respond to questions attached on a one hour phone interview. The questions have been attached to inform you about what will be asked on the phone interview. Your participation will be completely voluntary and you are free to withdraw at any time. Deciding to participate or not will not affect your relationship with Bowling Green State University. Any risks associated with participating in this interview will be considered as the minimal risk which you may have in your daily life. The investigator will never provide your name to anyone such as your boss, colleagues, Bowling Green State University, or any other organizations.

Procedure: In this research, two methods will be used for data collection. First, the Departments of Transportation with Public-Private Partnership legislation will be contacted to participate in a survey. They will be asked if they consider contractor’s experience in lean as one of the evaluation criteria for selecting the general contractor. Second, construction managers will be contacted to have a one hour interview to discuss the advantages of lean in Public Private Partnership projects and how they address lean principles on their proposals. At the end, these data will be combined and the advantages of lean in PPP projects will be discussed. This consent is associated with the second part of data gathering related to the interviews. Therefore, it will be appreciated if you, as a participant of the interview, respond to this email with your phone number and convenience time that you can be reached in order to have a one hour phone interview. Responding to this email with your phone number, the best convenience time to be reached, and your willingness to have the interview will be considered as your consent to participate as an interviewee. However, you will be asked to consent again when the...
principal investigator calls you. After the principal investigator receives your contact information, he will call you at your convenience time that you specified. The principal investigator will inform you that the conversation will be recorded (audio taped). Then he, the principal investigator, will again inform you about each item of this consent form and will ask you if you have any questions or concerns and if you consent to participate in the interview. You, as an interviewee, may decide to withdraw your consent and stop your participation without penalty or explanation.

Voluntary nature: Your participation in this interview is completely voluntary, and you can refrain from answering any questions without penalty or explanation. You are free to withdraw consent and to discontinue participation in the project at any time. If you decide to participate and change your mind later, you may withdraw your consent and stop your participation without penalty or explanation. Deciding to participate or not will not affect your relationship with Bowling Green State University.

Confidentiality/Anonymity Protection: Your name, other identifying information, and the audio taped will be confidentially recorded on the principal investigator’s laptop with personal password to access the data. Your name and other identifying information will not be released to anyone and only the principal investigator will be aware of your name. In case that the principal investigator decides to quote any of your responds, he will assign a code such as interviewee A, B, C, D, E, or F in order to make your name confidential. Also, deciding to participate or not will not affect your relationship with Bowling Green State University. Any risks associated with participating in this interview will be considered as the minimal risk which you may have in your daily life. The investigator will never provide your name to anyone such as your boss, colleagues, Bowling Green State University, or any other organizations. Also, all the data related to your identity will be deleted from the principal investigator’s laptop after his graduation in May, 2014. However, since e-mail and phone are not 100% secure, so it is possible that someone intercepting your e-mail will gain knowledge of your interest in the study.

Therefore, please note that you are encouraged to delete any emails that you receive from or send to the principal investigator of this study in order to decrease the risks associated with this issue. Also, if you provide your office number as your contact information, please note that the conversation may be tracked or heard by your company. Therefore, you may wish to respond to this email on your home computer or a public computer and provide your cell phone as your contact information instead of your office number. In addition, although the principal investigator will record your contact information and the audio taped on his personal laptop that requires a password to get access to the data, there is always the risk of breach of confidentiality and hacking. Therefore, if the breach of confidentiality happens for the principal investigator’s laptop, your name, e-mail address, phone number, and your responds to the interview questions may be stolen.

Risks: There is no physical risk in this study. Also, the anticipated risks to you are no greater than those normally encountered in daily life. However, as mention on the confidentiality section, there is always the risk of breach of confidentiality. E-mail and phone are not 100% secure. Therefore, to decrease the risks associate with this issue, you are encouraged to delete any emails that you receive from or send to the principal investigator of this study. Also, all the
data regarding your name, email address and the audio taped will be recorded on the principal investigator’s laptop which requires a password to get access to. No one except the principal investigator is aware of this password and he will never provide your contact information to anyone or any organization. However, if the breach of confidentiality happens, your name, email address, phone number, and your responds to the interview questions may be stolen. Also, if you provide your office number as the contact information, please noted that the conversation may be tracked or heard by your company. All the data regarding your name and contact information will be deleted from the principal investigator’s laptop after his graduation (May, 2014).

Contact information: If you have any questions about the research or your participation in this study, please contact me at rbmalek@bgsu.edu or 419-496-7760. You may contact my advisor, Dr. Gad, at gmgad@bgsu.edu or 419-372-5437. Also, you may contact the Chair, Human Subjects Review Board at 419-372-7716 or hsr@bgsu.edu, if you have any questions about your rights as a participant in this research. Thank you for your time.

I have been informed of the purposes, procedures, risks and benefits of this study. I have had the opportunity to have all my questions answered and I have been informed that my participation is completely voluntary. I agree to participate in this research.

This research obtained a waiver of written consent. Therefore, responding to this email with your phone number, the best convenience time to be reached, and your interest and willingness to have the interview will be considered as your consent to participate as an interviewee. However, you will be asked to consent again when the principal investigator calls you. After the principal investigator receives your contact information, he will call you at your convenience time that you specified for conducting the one hour phone interview with you. The principal investigator will inform you that the conversation will be recorded (audio taped). Then he, the principal investigator, will again inform you about each item of this consent form and will ask you if you have any questions or concerns and if you consent to participate in the interview. You, as an interviewee, may decide to withdraw your consent and stop your participation without penalty or explanation.
APPENDIX D: SURVEY CONSENT LETTER

Informed consent for participating in the survey for the study of lean principles application in public-private partnership project procurement

Introduction: My name is Ramin Malek, a graduate student from the Department of Construction Management at Bowling Green State University. I would like to invite you to participate in my research study to investigate LEAN PRINCIPLES APPLICATION IN PUBLIC-PRIVATE PARTNERSHIP PROJECT PROCUREMENT. You, as an individual representative of the legal section of your department of transportation, have been selected to participate in this survey because your state is legally authorized to have PPP projects based on Federal Highway Administration.

Purpose: The goal of this study is helping both Departments of Transportation and construction firms to have the same knowledge about lean principles and its advantages in order to construct more high-quality highways with less money in a shorter time. This research will help the Departments of Transportation to increase the awareness of contractors about lean in PPP projects. More specifically, this study will help contractors to know more about your department of transportation’s perspective about lean experience in PPP projects in bidding process. Also, this research will help you to let construction contractors know that how important lean is and make the process of choosing a contractor much easier for you and your department of transportation. Also, this study helps you and all end users, citizens and residents, to pay less tax for constructing highways and increasing the number of PPP projects and decreasing the risks associated with PPP projects by implementing lean as one of the evaluation criteria.

As a participant, you will be asked to respond to two questions below. Your participation will be completely voluntary and you are free to withdraw at any time. Deciding to participate or not will not affect your relationship with Bowling Green State University. Any risks associated with participating in this survey will be considered as the minimal risk which you may have in your daily life. The investigator will never provide your name to anyone such as your boss, colleagues, Bowling Green State University, or any other organizations.

Procedure: In this research, two methods will be used for data collection. First, the Departments of Transportation with Public-Private Partnership legislation will be contacted to participate in a survey. They will be asked if they consider contractor’s experience in lean as one of the evaluation criteria for selecting the general contractor. The two questions driving the survey are:

1. Does state DOTs consider lean application as one of the bidders’ qualifications criteria in PPP projects?

2. How much weight do DOTs allocate to lean in evaluating proposals?
Then construction managers with experience in PPP projects and lean will be contacted to have a one hour interview to discuss the advantages of lean in Public Private Partnership projects. On the phone interview, the construction managers’ perspective about implementing lean in PPP projects will be discussed. At the end, it will be compared that if both parties, the Departments of Transportation and construction managers, will consider the same level of importance for lean experience in evaluating the contractors’ proposals in PPP projects.

This consent is associated with the first part of data gathering related to the survey from the Departments of Transportation and it will take less than five minutes. Therefore, it will be appreciated if you, as a participant of the survey, respond to two questions below and email your respond to the principal investigator:

1. Does state DOTs consider lean application as one of the bidders' qualifications criteria in PPP projects?

2. How much weight do DOTs allocate to lean in evaluating proposals?

Responding to the questions of the survey and emailing the responds to the principal investigator will indicate your willingness and will be considered as your consent.

After the principal investigator finishes the data gathering from the survey, your respond to those questions will represent the rules and the perspective of your department of transportation regarding the importance of lean. The principal investigator will use this data to show how many states use lean as one of the evaluation criteria in selecting the contractors for PPP projects. Also, the weight that your department of transportation allocates for lean to evaluate the contractors’ proposals with the name of your state will be presented on the study.

Voluntary nature: Your participation in this survey is completely voluntary, and you can refrain from answering any questions without penalty or explanation. You are free to withdraw consent and to discontinue participation in the project at any time. If you decide to participate and change your mind later, you may withdraw your consent and stop your participation without penalty or explanation. Deciding to participate or not will not affect your relationship with Bowling Green State University.

Confidentiality/Anonymity Protection: Your name and other identifying information will be confidentially recorded on the principal investigator’ laptop with personal password to access the data. Your name and other identifying information will not be released to anyone and only the principal investigator will be aware of your name. However, your responds to the survey questions will represent your department of transportation's rules regarding the PPP projects. Also, deciding to participate or not will not affect your relationship with Bowling Green State University. Any risks associated with participating in this survey will be considered as the minimal risk which you may have in your daily life. The investigator will never provide your name to anyone such as your boss, colleagues, Bowling Green State University, or any other organizations. Also, all the data related to your identity will be deleted from the principal investigator’s laptop after his graduation in May, 2014. However, since e-mail and phone are not 100% secure, so it is possible that someone intercepting your e-mail will gain knowledge of your interest in the study. Therefore, please note that you are encouraged to delete any emails that you receive from or send to the principal investigator of this study in
order to decrease the risks associated with this issue. Also, if you respond to the survey with
the same email address that is provided on the department of transportation website,
please note that the email may be tracked by your department of transportation.
Therefore, you may wish to respond to this email on your home computer or a public
computer and use your personal email. In addition, although the principal investigator will
record your contact information on his personal laptop that requires a password to get
access to the data, there is always the risk of breach of confidentiality and hacking.
Therefore, if the breach of confidentiality happens for the principal investigator’s laptop,
your name and e-mail address and your responds to the survey questions may be stolen.
However, it should also be noted that your work email address and the information that
are asked in the survey are considered as the public data.

Risks: There is no physical risk in this study. Also, the anticipated risks to you are no greater
than those normally encountered in daily life. However, as mention on the confidentiality
section, there is always the risk of breach of confidentiality. E-mail and phone are not 100%
secure. Therefore, to decrease the risks associate with this issue, you are encouraged to delete
any emails that you receive from or send to the principal investigator of this study. Also, all the
data regarding your name, your email address, and your responds to the survey questions will be
recorded on the principal investigator’s laptop which requires a password to get access to. No
one except the principal investigator is aware of this password and he will never provide your
contact information to anyone or any organization. However, if the breach of confidentiality
happens, your name, e-mail address, and your responds to the survey questions may be stolen.
Also, if you wish to respond to this email with your personal email address, your personal email
address may be stolen in case of breach of confidentiality. If you decide to respond to this email
with your work email address, please noted that the conversation may be tracked or seen by your
department of transportation. All the data regarding your name and contact information will be
deleted from the principal investigator’s laptop after his graduation (May, 2014).

Contact information: If you have any questions about the research or your participation in this
study, please contact me at rmalek@bgsu.edu or 419-496-7760. You may contact my advisor,
Dr. Gad, at gmgard@bgsu.edu or 419-372-5437. Also, you may contact the Chair, Human
Subjects Review Board at 419-372-7716 or hsrb@bgsu.edu, if you have any questions about
your rights as a participant in this research. Thank you for your time.

Please note that you are encouraged to delete any emails that you receive from or send to
the principal investigator of this study after your participation.

I have been informed of the purposes, procedures, risks and benefits of this study. I have had the
opportunity to have all my questions answered and I have been informed that my participation is
completely voluntary. I agree to participate in this research.

This research obtained a waiver of written consent. Therefore, responding to the questions of
the survey will indicate your willingness and will be considered as your consent to participate
in this survey.