

The Effect of Pre-planning on Public Works Projects: A Policy Perspective

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The traditional approach to public construction does not normally include a formal pre-planning phase prior to award. This results in misalignment of expectations between the project participants, and can ultimately increase cost and schedule, and decrease overall satisfaction. In an effort to improve construction projects, the State of Minnesota Legislature created a 2007 policy that permits public entities to use "best value" procurement and project pre-planning. The main objective of this paper is to study the impact of this legislation on risk identification. This paper utilizes a fixed-effects regression model to compare project performance from two different public entities. One entity delivered projects using the structured pre-planning process before contract award (under the best value policy), and then measured project performance. The second entity also measured project performance, but did not have any formal pre-planning time. This paper analyzes 2,462 unique risks on 750 construction projects ($958.7M total value, average of $1.06M) with 27 contractors, over a six-year period (2006 to 2012). After controlling for project value and type, the results suggest that the pre-planning legislation encouraged contractors to identify issues about 50 percent earlier in the projects (compared to contractors who did not use the formal pre-planning).

Key Words: Risk Management, Public Policy, Project Delivery, Fixed Effects Regression

Introduction

Background and Problem

Many construction projects face varying levels of risk, due to a myriad of known and unknown events (Hillson 2009). The challenge is responding to these risks in a way that still delivers a high quality product to the client at an affordable cost. Furthermore, projects with increasingly complex scopes or unique conditions require better pre-planning and risk management (Bosch-Rekveldt *et al.* 2011). One of the most prevalent approaches to project risk management is the Probability – Impact (P-I) risk model (Franke 1987). Current research on the approach identifies the need to more accurately model the various complexities that projects face, and also analyze how these risks interact with one another (Taroun 2014). For years, various studies have clearly shown that one of the largest contributors to project failure is a lack of adequate pre-planning and risk management (Construction Industry Institute 1995; Loosmore *et al*. 2006; Perrenoud & Sullivan 2014).

Another major contributing factor to poor project performance is the owners' price-based approach to contractor selection (Sullivan, 2011). In the traditional low-bid system, design professionals prepare construction documents that attempt to describe, in detail, the exact specifications for the new facility. Contractors then compete on the project by providing prices to perform the work. The owner will award the project to the lowest responsible bidder, and the project begins. A recent study found that the cost of capital construction projects has increased by approximately 140 percent, excluding inflation (Westney Consulting Group, 2014)

While many owners attempt to identify risk during front-end planning, the propensity for risk continues for the life of the project. Certainly, there are unforeseen conditions and events that would necessitate additional risk management and planning. Chapman and Ward (2007) identify the need for a consistent approach to risk management through a standard methodology. It should be noted, however, that checklists and tools are not sufficient for managing risk – it takes the concerted effort of an expert to consider the unique risks for a given project (Hillson 2003).

One consideration for risk management is quantify the frequency and types of project risks (Anastasopoulos et al. 2010). For the purposes of this paper, Risk Encounter (RE) is defined as the percentage of the project that is completed at the time a risk is identified and communicated to all project stakeholders (see Perrenoud et al. 2015 for details of how the Risk Encounter was developed). It is a measure of when in time a risk is identified, relative to the baseline project duration. For example, a RE score of 0.5 means that the risk was identified at the 50 percent mark of time (half-way point) of the project's initial schedule duration. Lower scores mean that the risk was identified earlier on during the project. RE is calculated by formula 1 shown below:

$$\text{Risk encounter} = \frac{\text{Risk encounter date} - \text{Beginning contract date}}{\text{Original completion date} - \text{Beginning contract date}}$$

Overview of Value-Based Project Delivery

Best Value Procurement is a purchasing mechanism that considers both price and performance factors (Kashiwagi 2012; Sullivan 2011). While procurement refers to selection phase activities, the principles of best value can be expanded over a series of three phases that cover the entire project delivery lifecycle (see Figure 1).

Figure 1. Phases of the BVP (adapted from Kashiwagi, 2012).

At the completion of the selection phase, one "potential best value" contractor is invited to the Pre-Planning phase. Then, the contractor will give a summary of their proposal, explain why they think it will be successful, and provide a detailed plan to minimize project risk. The pre-planning phase is comprised of three stages (Kashiwagi, 2012):

1. Kickoff meeting – The critical client personnel attend a meeting where the potentially awarded firm presents important project details, including their schedule, potential risks and a plan to mitigate the risks, cost summary, and scope (what the contractor is actually doing for the project). The primary intent of this meeting is to help both parties (owner and contractor) align their expectations for what should transpire on the project.

2. Clarification activities – After the kickoff meeting, the team will participate in various activities that need to be completed. For example, the owner may need to provide additional technical information to the contractor or provide site access. The contractor may also request additional meetings with key personnel to better understand the project risk. Once both parties are comfortable, the contract document will be prepared based on the pre-planning documentation produced during this phase.

3. Summary meeting – Once the final contract is ready for signing, the contractor will conduct a final summary meeting. This meeting should be relatively straightforward, as all questions and issues should

have been previously resolved. The purpose of the meeting is essentially "one last review" before the contract is signed.

Best Value Legislation in the State of Minnesota

Various institutions started piloting best value construction project delivery in the State of Minnesota, beginning in 2005. After several successful pilot projects, the construction labor unions lobbied the legislature to enact best value construction rules (Minn. Gen. Laws. ch. 16C, § 28, 2007; Thomson et. al., 2007). The primary benefit of this law is that it minimized legal hurdles that would have normally prevented public owners from using best value procurement.

Data Sources

The researchers collected project performance information from two public organizations, a public university in the US State of Minnesota ("University") and a large international US military agency ("Agency"). The University was chosen because their projects had a formal preplanning time (the treated group with the policy change), whereas the Agency did not. The Agency would serve as a unit of comparison. Risk information (date the risk was communicated to the owner, cost impact, and schedule impact) was gathered from both institutions.

The risk data was collected on a Risk Register. The Risk Register is an Excel file that the contractor emailed to the owner (and researchers) on a weekly basis, for the duration of the project. The owner's project manager reviews each report for overall accuracy (e.g., known risks are listed, accuracy of values). The raw data was not naturally panel data; that is, risks are one-time unique events and cannot be measured over multiple time periods. However, the researchers combined risks for each contractor and year to create cross-sectional panel data (a total of 88 contractor-year observations). The dataset is based on an analysis of 2,462 unique risks from 750 projects ($958.7M total value) with 27 contractors. The mean project value is $1,058,860 (*SD* = $1,634,362), the mean risk cost impact is $97,755 (*SD* = $164,651), and the mean risk schedule impact is 175 calendar days (*SD* = 225 calendar days). A majority of the risks (70 percent) were due to owner schedule and cost changes, with the others attributed to unforeseen conditions (27 percent) and contractor issues (3 percent). The data spans the years 2006 to 2012, however not all contractor-year data started in 2006. Thus, the researchers realigned the data such that the first year from which a contractor had data was nominally set to year "1". There were ten key variables used in the regression model:

1. mean_rescore: This is the mean RE score (see Formula 1) for each contractor for the given year. It is calculated by first determining the RE score for each risk. The researchers then summed all of RE scores for a given contractor in a given year, and divided this sum by the total number of risks. This is the outcome variable of interest.
2. usedpreplan: This is a dichotomous variable that equals 1 if the contractor used a formal preplanning time. In other words, it identifies whether the given contractor-year was treated under the best value policy. This is the independent variable.
3. inv2_projects_mean_award: Like the mean RE score, the mean award is sum of the contract award amounts (in dollars) for a given contractor-year, divided by the number of risks in the same time frame. This is a control variable. The researchers transformed the data such that it better fit the normal trends of a construction project (see the cost influence curve in Figure 1). The researchers performed an inverse square of the natural log of the mean award value [$(1/\ln(\text{mean award value})^2)$]
4. inv2_projects_mean_duration: The mean project duration is the sum of the contract award duration (in calendar days) for a given contractor-year, divided by the total number of risks in the same time frame. It is a control variable. The researchers also performed an inverse square of the natural log transformation.
5. inv2_risks_mean_cost: The mean risk cost is the sum of the risk cost impacts (in dollars) for a given contractor-year, divided by the total number of risks in the same time frame. It is a control variable. The researchers also performed an inverse square of the natural log transformation.
6. inv2_risks_mean_sche: The mean risk schedule duration is the sum of the risk schedule impacts (in calendar days) for a given contractor-year, divided by the total number of risks in the same time frame. It is a control variable. The researchers also performed an inverse square of the natural log transformation.

7. risk_per_XXXX: These last four control variables are the relative percentage of the number of risks for a given contractor-year, by the risk source (own = owner, desn = designer, cont = contractor, and unfore = unforeseen).

Regression Model

The researchers use regression to understand the differences in risk communication between the two public agencies. First, the researchers present in Table 1 the summary statistics for the ten key variables:

Table 1

Summary Statistics

-> usedpreplan = 0

Variable	Obs	Mean	Std. Dev.	Min	Max
mean_rescore	33	.9106327	.4256532	.254636	2.096087
mean_award	33	1573208	874250.2	122700	4015198
mean_duration	33	358.2887	98.33799	222	640
meanrisk_cost	33	23485.93	31887.61	-3669.279	174998.5
meanrisksched	33	37.92185	24.97228	8.333333	102.6667
risk_per_own	33	.6878788	.2172953	.24	1
risk_per_des	33	.0218182	.0440493	0	.17
risk_per_con	33	.1012121	.1236365	0	.45
risk_per_unf	33	.1887879	.1607552	0	.67

-> usedpreplan = 1

Variable	Obs	Mean	Std. Dev.	Min	Max
mean_rescore	73	.7247124	.3199741	0	1.438095
mean_award	73	524907	594865	14150	2601898
mean_duration	73	105.8147	64.71923	12	330
meanrisk_cost	73	6655.08	11678.11	-8750	67650
meanrisksched	73	9.683672	16.16338	0	116
risk_per_own	73	.6545206	.2577469	0	1
risk_per_des	73	.1119178	.1554265	0	.61
risk_per_con	73	.1235616	.2018138	0	1
risk_per_unf	73	.1105479	.1614766	0	1

The researchers openly acknowledge several potential issues with the dataset and the underlying projects. First, there are more than twice as many observations of contractor-year units under the treatment of the best value policy. Though these observations are based on many projects, the imbalance of treated and non-treated observations could be an issue. A second issue is the size and scope of the projects. The mean award of projects that were delivered without the formal preplanning was about $1.57M, while the mean award amount of treated projects was about $524K. These project differences might indicate different scopes (in terms of complexity), which could affect when risks are communicated to the owner. However, informal interviews with project owners from both organizations indicate that most projects were tenant improvements – and therefore the overall ‘complexity’ should be about the same. A third is issue is that the two subject organizations are much different in terms of number of personnel and geographic location. The University projects occurred only the university’s campus in Minneapolis, with a small group of project managers (about 10 people). The Agency projects, however, are located in disparate regions throughout the world (but mostly in the United States). Also, the Agency is a large bureaucratic federal agency: there are several more layers of approval requirements and managers (as compared to the University).

The mean RE score for risks with the best value policy in place was 0.7247, while those that did not had a RE score of 0.9106. A *t*-test identified a statistically significant difference between the two, $t(108) = 2.4907$, $p < 0.0072$. Thus, there appears to be a difference between the two groups as measured by the RE score with respect to the use of preplanning. The fixed effects regression model is as follows:

$$mean_{rescore} = \beta_0 + \beta_1 usedpreplan + \boldsymbol{X}'\gamma + a_i + d_t + \varepsilon_{it}$$

Regression Results

The standard OLS model (without year and contractor effects) results are presented in Table 2.

Table 2

OLS Model Regression Results

Linear regression

Number of obs = 88
F(9, 78) = 2.96
Prob > F = 0.0044
R-squared = 0.2151
Root MSE = .28319

mean_rescore	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf. Interval]	
usedpreplan	-.1830462	.1074519	-1.70	0.092	-.3969666	.0308741
inv2_projects_mean_award	13.70777	61.91285	0.22	0.825	-109.5512	136.9668
inv2_projects_mean_duration	2.418026	4.611653	0.52	0.602	-6.76307	11.59912
inv2_risks_mean_cost	-.2799868	3.423762	-0.08	0.935	-7.096174	6.5362
inv2_risks_mean_sche	-.0015082	.0050917	-0.30	0.768	-.011645	.0086285
risk_per_own	8.371844	7.750794	1.08	0.283	-7.058801	23.80249
risk_per_desn	9.17745	7.715296	1.19	0.238	-6.182524	24.53742
risk_per_cont	9.105528	7.686855	1.18	0.240	-6.197824	24.40888
risk_per_unfore	9.271048	7.880047	1.18	0.243	-6.41692	24.95902
_cons	-7.878323	7.798593	-1.01	0.316	-23.40413	7.647483

The OLS results are statistically significant at the 90 percent level (*p*-value on usedpreplan = 0.092), and it also carries the expected sign. The OLS model results suggest that when risks did occur on project with formal preplanning (the policy was in place), the RE score would decrease by about 0.183.

Next, Table 3 presents the full fixed effects (FE) regression model. While the FE model attempts to account for some potential sources of variation (contractors and years), it does not adjust for everything. It is possible that there were other influences on the model that had an effect on when risk was communicated. Nonetheless, when including the contractor and year fixed effects, the model has slightly more significance (*p*-value on usedpreplan = 0.087), but the coefficient on the outcome variable drastically decreases (-0.5584). Note that in the fixed-effects model all of the controls remain statistically insignificant with exception to risk's schedule impact (*p*-value on inv2_risks_mean_sche is 0.036).

Table 3

Fixed Effects Model Regression Results

Linear regression

Number of obs = 88
F(36, 49) = .
Prob > F = .
R-squared = 0.7721
Root MSE = .19252

mean_rescore	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
usedpreplan	-.5585387	.3201265	-1.74	0.087	-1.201857	.0847796
inv2_projects_mean_award	-37.69237	72.11442	-0.52	0.604	-182.6117	107.227
inv2_projects_mean_duration	9.525285	7.451765	1.28	0.207	-5.449597	24.50017
inv2_risks_mean_cost	4.633838	4.364482	1.06	0.294	-4.136917	13.40459
inv2_risks_mean_sche	.0182396	.0084351	2.16	0.036	.0012886	.0351906
risk_per_own	10.26565	7.666451	1.34	0.187	-5.140663	25.67196
risk_per_desn	10.63364	7.65537	1.39	0.171	-4.750407	26.01768
risk_per_cont	10.17438	7.703741	1.32	0.193	-5.306865	25.65563
risk_per_unfore	10.74842	7.676313	1.40	0.168	-4.677711	26.17455

Discussion and Conclusion

Though there are several limits of the data used in this paper (see discussion in the previous section), the initial results indicate that the University's procurement policy that included a formal pre-planning phase has resulted in project issues being communicated earlier during a project by about 50 percent. Identification of risks earlier during a project will generally result in a lower cost impact (compared to identifying a risk near the end of the project, for example). The coefficient on inv2_risks_mean_sche is statistically significant. Further analysis is needed to understand implications of this result, but the researchers surmise that significant schedule impact events somehow impact the point in time that they are communicated.

Public policymakers should see increases in public benefit by reducing the cost of delivering projects. Furthermore, public officials can also seek to measure value by quantifying performance of their projects. While this paper did not at all consider the impact of measuring project performance, this data is what actually made the research possible. This paper does not discuss the operational activities that had to take place in order for the owners and contractors to be able to preplan their projects or measure performance. In other words, the researchers propose that successful implementation of a best value policy requires more than just enacting new legislation (though this is certainly important). A significant amount of education took place at both the University and the Agency on how to successfully navigate a best value project.

Future research should look at the source of risks and develop a profile for how preplanning policy affects the various parties during project delivery. A similar study could also be carried out with the types of projects – do certain types of projects gain more benefit from preplanning than others? Further efforts could also be done to understand how project cost or schedule changes are impacted by preplanning policy. This study would be useful to provide a tangible measure (in dollars) that would provide policymakers incentives to at least review their project delivery legislation.

The primary limitation of this research is the differences in terms of people, project scope, geographic location, and contractors between the University and the Agency. While the data presented was the only information available, these differences could make a significant impact. Ideally, the researchers would have liked to use a difference-in-differences regression model, but project performance data before Minnesota enacted the best value policy was not available.

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Appendix 1 – Risk Register Example

	A	B	C	D	E	F	G	H	I
1	NO	DATE ENTERED	RISK CATEGORY	RISK DETAILS	PLANNED RESOLUTION DATE	ACTUAL DATE RESOLVED	IMPACT TO OVERALL PROJECT DURATION	IMPACT TO OVERALL PROJECT COST	CPPM PM SATISFACTION RATING
2	**0**	**1/15/09**	**Please identify the party responsible for the risk from the drop down menu**	**Please describe the details of the risk:** **1. What is the risk / why was it unexpected?** **2. What will be done / what is plan to minimize this risk?** **3. Who is responsible for resolving the issue?** **4. What kind of impact will this have?** **5. Any updates to this risk (if applicable)**	**2/15/09**	**2/1/09**	**15**	**$10,000**	**5**
3	1	9/9/11	6) UNFORESEEN IMPACT	1) We had found the existing slab to be 2 to 3 times thicker than normal, which added costs for sawcutting removal, jackhammering, and also footings, pier footings, cast iron pipe, all were uncovered as we removed the floor, and not on plans. Also found existing floor over tunnel needed to be shotblasted and then apply self leveling compound mandated by a PR#1 request from architect. 2) We have given added cost estimate for all added work, and it has been accepted. 3) The architect is responsible for resolving the issue and we will do the work. 4) This willl have an added cost and schedule impct to the project, 3 added weeks 5) We are proceeding with the work.	9/17/11	9/17/11	21	$15,105	10
4	2	9/16/11	2) CLIENT IMPACT - Scope Change / Decision	1) The user has asked to have certain things removed and changed on the project. 2) We have been sent a PR2 change request for pricing this morning by the architect, and are waiting for reponses from all subs that are affected by changes. 3) the architect is reponsible for authorizing the changes. 4) This end's up being a credit back impact to the project. 5) Updated costs today for this credit back 9-22-2011	9/23/11	9/23/11	0	$5,280	10