Lessons learned from one of New Zealand's most challenging civil engineering projects: rebuilding the earthquake damaged pipes, roads, bridges and retaining walls in the city of Christchurch 2011 - 2016.

# Relationship Between Early Contractor Involvement and Financial Performance

**Story:** Early Constructor Involvement (ECI)

**Theme:** Programme Management

---

A paper written by Paul S. Botha and Eric Scheepbouwer for the Transportation Research Record: Journal of the Transportation Research Board, No. 2504, Transportation Research Board, Washington, D.C., 2015, pp. 66–72.

Programme funded by
Christchurch City Council
New Zealand Government

# Relationship Between Early Contractor Involvement and Financial Performance in the Rebuilding of Infrastructure in Christchurch, New Zealand

Paul S. Botha and Eric Scheepbouwer

**Alliance contracting is a partnering project or program delivery method in which all parties work collaboratively to share risks. The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) alliance has been set up to manage the high risk of the unknown scopes of work associated with disaster recovery projects after the 2011 earthquakes in Christchurch, New Zealand. SCIRT uses early contractor involvement (ECI) as a key measure of risk mitigation and to offer value for money. ECI provides constructability input during the design process to ensure that any issues and construction risks are identified early and taken into consideration. Because there has been considerable pressure to start the rebuilding, not all SCIRT projects have had the benefit of ECI. With the objective of quantifying the positive effect that ECI has on financial outcomes, 288 projects that were in construction or had been finished by the end of February 2014 were compared. The comparison was based on whether ECI had been used both during the design phase of a project and in the cost estimation of the project. The results clearly showed that across the alliance program there was significant improvement in cost performance and cost accuracy of reconstruction projects that received early contractor input.**

Following the first earthquake on September 4, 2010, Christchurch, New Zealand, suffered a substantial amount of damage to its infrastructure. An emergency response program was put together by the city council and referred to as the Infrastructure Rebuild Management Office. Under this arrangement, the city was divided into four geographical areas; each area was allocated to a civil construction company to manage the design and construction of the repair works. A second large earthquake on February 22, 2011, resulted in the loss of 185 lives, extensive damage to buildings and houses, widespread liquefaction, and a significant increase in the amount of damage to the city's already damaged infrastructure. The extent of the damage and the resulting increased need for resources meant that a different delivery model was needed to manage and coordinate the rebuild. The need to combine resources and share knowledge to ensure that the damaged infrastructure would be reinstated as quickly as possible and that the rebuild could be completed within a 5-year period, combined with the risk associated with the unknown scopes of work and further seismic activities, made an alliance the ideal program delivery model (*1–4*).

P. S. Botha, Stronger Christchurch Infrastructure Rebuild Team, 1 Magdala Place, Middleton, Christchurch 8024, New Zealand. E. Scheepbouwer, Department of Civil and Natural Resources Engineering, University of Canterbury, Private Bag 4800, Christchurch 8140, New Zealand. Corresponding author: E. Scheepbouwer, eric.scheepbouwer@canterbury.ac.nz.

*Transportation Research Record: Journal of the Transportation Research Board, No. 2504,* Transportation Research Board, Washington, D.C., 2015, pp. 66–72.
DOI: 10.3141/2504-08

Alliance contracting has previously been used as a delivery model in which organizations work collaboratively and share responsibility and risk (*4*). The alliance approach to project delivery is basically a different way of targeting project outcomes and sharing risk. Initially, the alliance model was of a form that is now commonly known as a "pure" alliance. This model has been widely investigated and reported on (*5–12*). More recently, other variants of the alliance model have been implemented; these variants differ significantly from the pure alliance model and offer a project delivery model that can be suited to different situations (*13*).

One of the benefits of the alliance approach is having access to construction personnel during the design phases of the project to help make more informed decisions to optimize the design and manage the risks (*14*). In the Stronger Christchurch Infrastructure Rebuild Team (SCIRT) alliance, contractor involvement is provided by the contractors in a structured process to provide the design teams with constructability advice and ensure that any issues and construction risks are identified and taken into consideration early in the design process (*15*). Another objective of early contractor involvement (ECI) is to ensure that the project costing is well informed and has a safe methodology and that any identified construction risks are properly assessed.

Disaster recovery projects are comparable to major infrastructure projects (*2*), and major infrastructure projects have a history of incurring cost overruns, which are often a result of ineffective risk management and a lack of accountability (*16*). In the United States, the Construction Industry Institute stated that partnering offered opportunities to improve the cost-effectiveness of construction projects (*17*). In the United Kingdom, Latham argued that partnering could reduce costs as well (*18*). Several authors have identified a commitment to partnering from all involved parties, ECI during the design, the identification of risk, and trust and relationships as key factors for mitigating risk and increasing the likelihood of meeting target project costs (*19, 20*). But no research has been found that quantifies the effect of the factors on cost certainty or on the reduction of the cost of alliance contracting. In the present research, the financial data from 288 projects that are in construction, handover, or practical completion are used to illustrate how, in an alliance, contractor input early in the design process affects the final cost outcome and cost certainty of the projects.

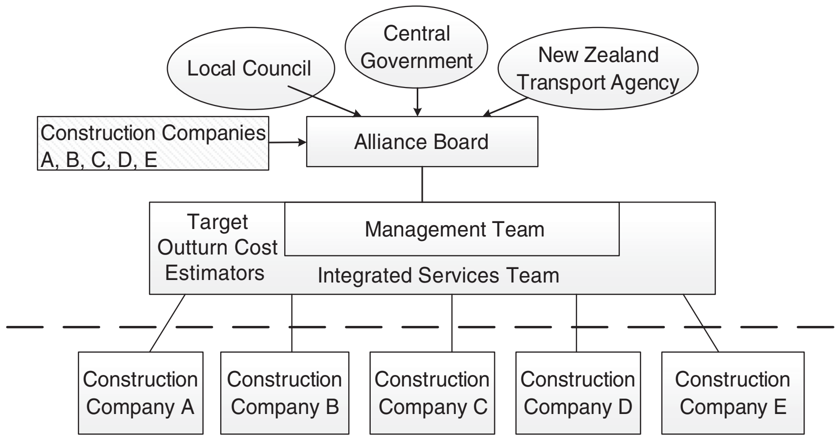


FIGURE 1 SCIRT organizational structure.

## SCIRT ALLIANCE

In New Zealand, SCIRT was set up as a multiclient–multicontractor alliance in September 2011 (*13*). The alliance is responsible for assessing the infrastructure network for earthquake damage and managing, coordinating, prioritizing, designing, estimating, and delivering the various work packages that are needed to rebuild Christchurch's damaged infrastructure. SCIRT consists of eight parties. The local council, the central government, and the New Zealand transport agency are the owner participants and funding agencies; five of New Zealand's largest civil engineering construction companies are the nonowner participants (*3*). All other companies or individuals that cooperate in the infrastructure rebuild are employed by SCIRT but are not part of the alliance.

The alliance consists of a board, a management team, and an integrated services team (IST), as shown in Figure 1. The board consists of the chief executive officers of the participants and oversees the management team that manages the day-to-day operations; both the board and the management team are formed by staff seconded to SCIRT from the participants. The IST is made up of specialists such as quantity surveyors, designers, planners, and asset managers; these specialists provide all the asset assessment, project prioritization, concept design, and detailed design services. These specialists are either seconded from the participants or selected through a request for professional services procurement process. During peak times there were 270 full-time staff employed in the IST offices. Since the earthquakes were a national disaster and all companies were keen to participate, there was no difficulty finding staff.

One of the responsibilities of the IST is to determine the target cost for each project independently of the construction companies (*13*). The independence is set up to ensure that fair trade practices are followed. In alliance contracting, the target cost is referred to as the "target outturn cost" (TOC); in SCIRT the TOC represents the estimated physical construction cost and the on-site supervision only. Other costs, such as the design costs, are paid on a cost-reimbursable basis to the design companies and form part of the total project cost to the client but are not included in the project TOC. This definition differs from the calculation of the TOC in other alliances, in which direct project costs, such as design, are also part of the TOC (*13*).

The rebuild of the city's infrastructure is scheduled to be completed in December 2016 and is referred to as the program of works. The infrastructure includes such assets as nationally owned and council-owned roads and bridges, water supply reticulation and water storage reservoirs, wastewater reticulation and pump stations, and stormwater reticulation and pump stations. The program is divided into smaller projects, each identified with a unique project number. Each of these projects is designed by one of the design teams, which are embedded in the IST. After a project has been estimated for cost, the project is allocated to one of the construction companies for construction. In SCIRT the construction companies have set up offices for the delivery teams apart from the IST (*3*). This situation seems counterintuitive for an alliance (*14*); however, only the actual construction teams are located in the separate offices, and there is still a lot of collaboration with the designers and other IST staff during construction. In Figure 2 a SCIRT project life cycle is displayed. Each stage in the cycle is referred to as a "gate."

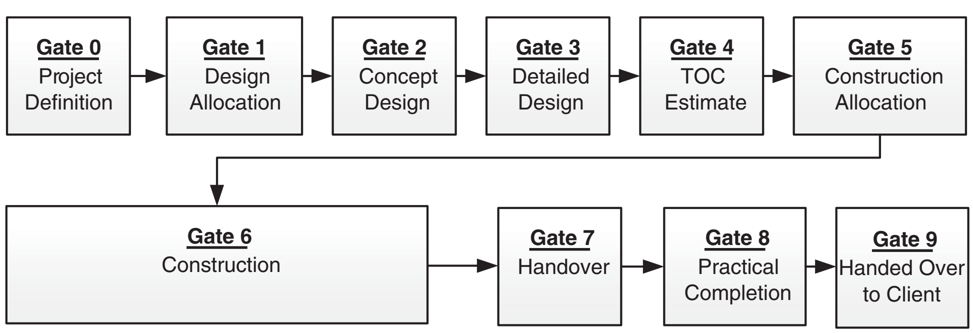


FIGURE 2 SCIRT project life cycle.

Each of the projects is delivered on a cost-reimbursable basis with a pain–gain share agreement. According to this agreement, the sum of all the cost savings and cost overruns of the projects will be split between the participants of the alliance at the conclusion of the SCIRT program. This pain–gain sharing is capped at the amount of the indirect costs of the contractor (*14*); in other words, the contractors are always paid the direct project costs but could lose or gain an amount equal to the profit plus the corporate overheads margins.

The SCIRT alliance has been set up to reward good performance with an increase in the allocation of the future workload. The future work allocation is based on a delivery performance score that is calculated as the financial performance of each delivery team's projects against the TOC as well as the performance against several noncost key performance areas. The delivery performance score has been set up to create price tension between the delivery teams in a collaborative environment and provide the client organizations with value for money (*3, 13*).

The construction work has been prioritized and generally starts with the asset that is the most critical, the deepest, and the most expensive: the wastewater reticulation network. This asset is follow by road, water supply, and stormwater assets. Existing sewer catchment areas have been used as identifiers for repairs to all assets in a particular area of the city. Work has also been designed in this order, starting with the wastewater reticulation and pump stations for each catchment, followed by the roadway packages and other assets in the same area.

## ECI IN SCIRT

In the SCIRT rebuild program, each delivery team should have a dedicated ECI manager who works collaboratively with the design teams to provide constructability input into the design to ensure that all construction risks have been taken into consideration (*15*). This input is achieved through regular meetings as well as risk and constructability workshops. These interface meetings are led by the ECI manager from the delivery team, who is also responsible for ensuring that all key milestones are met.

At the end of the detailed design phase, the ECI manager is responsible for submitting the required deliverables for consideration to the IST estimator who is pricing up the work. The required key deliverables are the methodology, the traffic staging details, the construction schedule in bar chart format, the updated risk register, and the inspection and test plan. It is also the responsibility of the ECI manager to review the bill of quantities prepared by the designers to confirm that it accurately reflects the scope of work and ties in with the proposed methodology to construct the work safely. (See Table 1 for the key roles and responsibilities during ECI.) The three key roles in ECI are the leader of the design team, the project manager or delivery lead as leader of the construction team, and an ECI manager.

On completion of the detailed design of a project, after the submission of the ECI deliverables and design documentation, the IST estimator, the ECI manager, and an independent (external) estimator arrange a handover meeting during which the project is discussed and any concerns about or differences in methodology are resolved and agreed. The independent estimator is employed directly by the owner participants of SCIRT and is not part of the alliance. During the handover meeting the discussions concern methodology, duration, and risks; discussions about price are prohibited to ensure the independence of the TOC and to prevent any direct influence from the delivery teams. After this meeting the TOC for the project is estimated by the resident IST estimators.

The TOC is determined from a first principle buildup, a process that adds the cost of material (determined by supply pricing from the market) and the costs of equipment and labor (determined by rates agreed with the independent estimator). The independent estimator signs off on each TOC once an agreement is reached through a parallel estimating process (*3*). The presence of an independent estimator in this process serves to ensure that the right procedures are followed and that the TOC has been set correctly. Once the TOC has been signed off on and the project is allocated to a delivery team for construction, the TOC can only be adjusted through an approval process referred to as work scope change. Work scope changes are only approved for client instructions and changes in design or project definition.

This ECI process provides the delivery teams with an opportunity for early construction planning and to understand the project and plan for construction. In Figure 2, ECI would involve collaboration at Gates 2 and 3 and input at Gate 4. The final allocation of the project to a delivery team occurs after the TOC has been set (Gate 5); the provision of early contractor input during the design of a project is no guarantee that the project will be allocated to the delivery team who provided the input.

## DEFINED PERIODS WITHIN PROGRAM OF WORKS

In the quick transition from the disasters to the rebuilding of the infrastructure, three distinct periods within the program of works could be identified: the transition, the ramp up, and the steady state. A fourth period, the ramp down, will occur gradually across the program. During this period staff and contractors will transition out of

**TABLE 1 Key Roles and Responsibilities During ECI**

| ECI Team Member | Responsibilities |
|---|---|
| ECI manager from delivery team | Lead and chair ECI team interactions<br>Ensure that key dates are met<br>Review bill of quantities |
| Design lead | Identify and communicate design parameters and issues<br>Evaluate input from delivery team and integrate modifications as required to the design and risk register |
| Delivery lead–project manager | Communicate construction methodology and any associated issues<br>Evaluate input from designer and make modifications as required to the methodology and risk register |

the rebuild program and back to their usual business. Each of these periods has had some unique characteristics that have significantly impacted the financial performance of the program of works.

### Transition Period

After the signing of the alliance agreement in September 2011, all the projects identified under the previous delivery program (the Infrastructure Rebuild Management Office) were transferred to SCIRT. Projects with designs that were either completed or well advanced were estimated and constructed under the SCIRT alliance commercial model. These projects were prioritized for construction during the transition period, which lasted from October 2011 to February 2012. The projects were mostly water mains, although the first of the gravity wastewater projects was also estimated and delivered during this period.

During the Infrastructure Rebuild Management Office period, the projects had been procured on a basis similar to a typical design–build project: each contractor had independently engaged and managed a design consultancy to provide the professional design services. The designs were therefore well informed, and the identified construction risks were well developed and incorporated into the design and construction methodologies.

### Ramp-Up Period

SCIRT has an obligation to complete the program of works within a set period of time (*3*). To achieve this goal, a certain volume of work was scheduled to be completed per month across the program. This schedule, in turn, required every gate in the process to meet a minimum monthly target. During the ramp-up period, March 2012 to October 2012, more complex projects were designed than during the transition period. These projects were typically large-diameter pressure mains, wastewater pump stations, and civil structures such as bridges. To meet the program completion date of December 2016, a minimum monthly construction expenditure was required. Because of the increase in project size and a lack of resources from delivery teams while the systems and procedures in the IST were being developed, early contractor input during the design was limited. During this period there were few formal risk and constructability workshops as everyone focused on constructing the work packages in the field.

### Steady State Period

As the staff became more familiar with the SCIRT processes, and business systems were developed, ECI became a formalized and documented process. During the current steady state period, November 2012 to date, there has been an increased focus from SCIRT on improving constructability input into the design and informing the independent TOC development in accordance with the ECI guidelines.

Projects designed during this period have had risk workshops and constructability workshops, attended by the nominated ECI team to provide constructability input into the design and ensure that construction risks have been identified and mitigated as much as possible. During the steady state period, formal handover meetings and site visits have been scheduled with the IST estimator to ensure that the methodology and risks are understood and taken into consideration for TOC development.

## METHODOLOGY

An analysis has been done on the monthly financial data of all 288 SCIRT projects that were in construction, handover, or practical completion or that had been handed over to the client (Gates 6 to 9; see Figure 2) by the end of February 2014. The available project data contained the program period, the name of the delivery team, the present status of the project, the planned completion date, the date TOC deliverables were submitted, the original TOC value, the revised TOC value (adjusted after approved work scope changes), the cost to date, and the forecast final cost. The forecast final cost is the sum of the total cost paid to date and the cost for the completion of the work (according to the project manager).

In the analysis, the mean project cost outcomes were calculated for projects that were grouped on the basis of two variables. The first variable was the timing of the project or the program period during which the project was designed and constructed. The second variable was ECI and covered whether the project had had no ECI deliverables handed in, late ECI deliverables, or ECI deliverables that were handed in on time.

The results of the quantitative analysis were verified through discussions with the SCIRT risk manager, members of the SCIRT management team, and delivery team members. Although some factors—such as the procurement of subcontractors, the experience of certain staff, or risk events that may have occurred on site—may have affected individual project outcomes, it is assumed that these effects were averaged out because of the many projects used in the analysis.

## DATA ANALYSIS

All statistical analyses were performed with SPSS Version 20. A normality test was performed with the mean cost overruns as the dependent variable per period of projects with submitted deliverables, and through the use of the normal quantile–quantile plot, the variable was found to be approximately normally distributed. A univariate analysis of variance was calculated, and the estimated marginal means of the cost overrun per period in the program were analyzed to assess the financial impact of ECI on the TOC estimate for each project. The project cost outcomes were calculated as a percentage of the TOC:

$$\text{project cost} = \frac{\text{forecast final cost} - \text{TOC}}{\text{TOC}} \quad (1)$$

A positive outcome indicated that there was a cost overrun, and the project was said to be in “pain”; a negative outcome indicated a cost saving (a cost underrun), and the project was said to be in “gain.”

## RESULTS AND DISCUSSION

The 288 projects were divided into three distinct time periods: transition, ramp up, and steady state. Over these periods the project size increased steadily (see Table 2 for mean project sizes by period).

From the calculation of the mean project cost outcomes in each period of the SCIRT program, it is evident that the program performed

**TABLE 2 Average Project Size per Period in SCIRT Program**

| Program Period | Number of Projects | Mean Project Size ($ millions) |
|---|---|---|
| Transition | 55 | 0.59 |
| Ramp up | 94 | 2.03 |
| Steady state | 139 | 3.79 |
| Total | 288 | 2.60 |

differently throughout the duration of the rebuild (see Table 3). During the transition stage, the program performed well financially, with an average 1.6% cost saving. There were still many small emergency repair projects, of which the design and TOC development were not well informed, but once the designs of these smaller projects were completed, the design of the larger projects started.

In the following ramp-up period there was an average cost overrun of 12%. During this period the average project, across all delivery teams, suffered significant cost overruns against the TOC. At this time there was pressure to demonstrate progress and give the people of Christchurch confidence in the rebuild. This pressure meant that projects during this period were designed and priced with a less than optimal constructability input. This lack of input led to situations in which some designs were at risk of being incomplete, and the independent TOC development was often uninformed about the correct methodology and associated risks.

The ramp-up period also saw a significant increase in project size (see Table 2 for the average project size during the ramp-up period); this increase occurred during a time when the SCIRT business systems and reporting structures were still being developed.

As a result of the pressure to construct the increased volume of work during the ramp-up period, the delivery teams had to increase their workforces, and some of the new staff was inexperienced in the concept of alliance contracting (*1*). The large difference between the upper and lower bounds of the mean cost overruns was indicative of the large variance in the performance of the individual projects.

In the steady state period, the program showed a significant improvement in financial performance against the TOC, with a cost overrun of 0.9%.

## COST OUTCOMES OF PROJECTS AND SUBMITTAL OF ECI DELIVERABLES

As a result of the designs being developed under the Infrastructure Rebuild Management Office arrangement, ECI during the transition period was interactive and informal. The design of these projects was completed during a period when the designers were reporting directly to the construction company. When these projects were transferred to the SCIRT program for estimating and construction, there was no requirement from the IST to submit the ECI deliverables before the estimate could be completed.

During the ramp up, some projects started construction before the design and TOC were completed. Very little effort from the delivery teams was put into properly informing the design and the TOC estimate as the teams were under pressure to start constructing the projects. There was also no requirement during the ramp up to get the deliverables submitted before the TOC was signed off on nor was there any communication with the estimator. Toward the end of the ramp-up period, the ECI guidelines were released, and the IST instructed that no construction activity was to start before the TOC had been finalized.

During the steady state period, the TOCs have not been allowed to be released before the deliverables have been submitted and any differences with the methodology have been resolved. However, at the start of the steady state some projects were already being estimated for which deliverables had not been received on time.

The mean cost overruns for projects grouped according to the submittal of ECI deliverables were analyzed per period in the program to date (Table 4). For this analysis the date the deliverables were uploaded to the SCIRT document control system was compared with the date the TOC was signed off on and released. From an estimating perspective, submitting the deliverables late had the same result as not submitting the deliverables at all: the deliverables were either taken into account in the estimate or they were not. From a project perspective, the deliverables being submitted late indicated that construction planning had been undertaken for the project.

The four projects in the transition period with deliverables that were submitted late showed an average −24.8% overrun, or a 28.4% cost saving; however, the small sample size caused the standard error of the mean, 16.4%, to be large. When the upper and lower bounds of these projects (8.1% and −57.7%, respectively) is taken into consideration, it can be argued that preconstruction planning made a positive difference in the performance of these projects.

During the ramp up, projects for which no deliverables were submitted had the biggest average cost overrun in the program of 14.3%; projects during the same period for which deliverables were submitted on time had an average saving of 0.1%. This result shows that there was an improvement of 14.4% against the TOC of projects for which deliverables were submitted on time during the ramp-up period. During the same period, there was a 3.9% improvement of performance against the TOC on projects for which deliverables were submitted late and therefore had the benefit of preconstruction planning but for which the TOC estimation was not informed.

**TABLE 3 Estimated Project Cost Outcomes per Program Period**

| Program Period | Number of Projects | Mean Cost Overrun (%) | SD in Cost Overrun (%) | 95% Confidence Interval Lower Bound (%) | 95% Confidence Interval Upper Bound (%) |
|---|---|---|---|---|---|
| Transition | 55 | −1.6 | 4.8 | −11.1 | 7.6 |
| Ramp up | 94 | 12.0 | 3.7 | 4.7 | 19.2 |
| Steady state | 139 | 0.9 | 3.0 | −5.1 | 6.8 |

NOTE: SD = standard deviation.

**TABLE 4 Estimated Mean Cost Overruns Relative to TOC of Projects: Input of ECI Deliverables**

| Program Period | ECI Deliverables | Number of Projects | Mean Cost Overrun (%) | SE Mean Cost Overrun (%) | 95% Confidence Interval Lower Bound (%) | 95% Confidence Interval Upper Bound (%) |
|---|---|---|---|---|---|---|
| Transition | Not submitted | 51 | 0.2 | 4.6 | –9.0 | 9.4 |
| | Submitted late | 4 | –24.8 | 16.4 | –57.7 | 8.1 |
| Ramp up | Not submitted | 59 | 14.3 | 6.5 | 1.5 | 27.1 |
| | Submitted late | 27 | 10.4 | 9.5 | –8.5 | 29.4 |
| | Submitted on time | 8 | –0.1 | 17.5 | –34.9 | 34.7 |
| Steady state | Not submitted | 21 | 4.1 | 4.9 | –5.5 | 13.8 |
| | Submitted late | 57 | 2.6 | 3.0 | –3.3 | 8.4 |
| | Submitted on time | 61 | –0.3 | 2.9 | –5.9 | 5.4 |

NOTE: SE = standard error.

Projects in the steady state for which deliverables have been submitted on time are performing similarly to the projects in the transition period for which no formal deliverables were submitted. The projects in the steady state for which deliverables have been submitted late or not at all are performing slightly worse than the projects in the steady state for which deliverables have been submitted but better than similar projects in the ramp up.

The combined estimated marginal mean cost overrun of projects for which deliverables have not been submitted or have been submitted late for TOC sign-off during the steady state period is 3.0%; the projects in the same period for which deliverables have been submitted have an estimated marginal mean gain of –0.30%, which indicates that there has been a 3.3% improvement in performance against the TOC on projects for which the estimate and design have been well informed.

## CONCLUSIONS

The SCIRT alliance model was developed to enable all parties to work collaboratively to optimize the design solution and reduce risk through access to ECI during the design of a project. The ECI measure not only provides constructability input into the design but also significantly informs the TOC estimate of each project and therefore gives the client organization certainty in the cost of the work. When the program is broken into three distinct periods, it is evident that with early contractor input into the design and TOC development, the projects perform better financially and provide the client organizations with more price certainty. The three periods in the recovery period—transition, ramp up, and steady state—each had different early contractor inputs.

The difference in the cost performance of projects between the transition stage and the ramp up was 10.4%; the difference between the ramp up and the steady state was 11.1%, with an average 10.7% financial improvement in projects that had ECI during design and price development. The financial performance of projects during the ramp-up phase was significantly worse than in the two other periods; the poorer performance was caused by the high pressure to get on with the work.

In the final period, the combined estimated marginal mean cost overrun of the projects for which deliverables have not been submitted or have been submitted too late is 3.0%; the projects in the same period for which deliverables have been submitted on time have an estimated marginal mean cost saving or underrun of 0.3%. This finding indicates that there has been a 3.3% improvement in financial performance on projects that have had ECI.

Through the preparation of the ECI deliverables that are required for TOC development, the delivery team, by definition, is undertaking a substantial component of the preconstruction planning of a project. This situation is evident from the following result: projects that had deliverables submitted late for the TOC development still performed better than projects that had no deliverables submitted at all.

Use of ECI, whether informal and interactive or formal and documented, provides price certainty to client organizations through the provision of construction input during the design and the identification of construction risks. Good procurement practices and project management techniques are still required for the successful outcome of construction projects: ECI during the design and price development stages is not a guarantee of the financial performance of a project.

In present research the only variable that was consistently controlled for when the projects were divided into comparison groups was ECI; all other factors were randomly distributed. However, the individual effects of the other contributing factors, such as the procurement of subcontractors, the experience of the staff, or risk events that may have occurred on site, did affect the financial outcomes of individual projects. It is evident from the large differences in the individual financial outcomes that these factors deserve attention in future research.

## REFERENCES

1. Chang, Y., and S. Wilkinson. Managing Resources in Disaster Recovery Projects. *Engineering, Construction and Architectural Management,* Vol. 19, No. 5, 2012, pp. 557–580.
2. Koria, M. Managing for Innovation in Large and Complex Recovery Programmes: Tsunami Lessons from Sri Lanka. *International Journal of Project Management,* Vol. 27, No. 2, 2009, pp. 123–130.
3. Provost, L. Auditor-General's Overview: Effectiveness and Efficiency of Arrangements to Repair Pipes and Roads in Christchurch. Office of the Auditor-General, Wellington, New Zealand, Nov. 9, 2013. http://www.oag.govt.nz/2013/scirt.
4. Eriksson, P. E. Partnering: What Is It, When Should It Be Used, and How Should It Be Implemented? *Construction Management and Economics,* Vol. 28, No. 9, 2010, pp. 905–917.
5. Bresnen, M., and N. Marshall. The Engineering or Evolution of Cooperation? A Tale of Two Partnering Projects. *International Journal of Project Management,* Vol. 20, No. 7, 2002, pp. 497–505.

6. Fisher, N., and S. Green. Partnering and the UK Construction Industry the First Ten Years: A Review of the Literature. In *Modernising Construction,* National Audit Office, London, 2001, pp. 58–66.
7. Green, S.D. Partnering: The Propaganda of Corporatism? *Journal of Construction Procurement,* Vol. 5, No. 2, 1999, pp. 177–186.
8. Li, H., E.W.L. Cheng, and P.E.D. Love. Partnering Research in Construction. *Engineering, Construction and Architectural Management,* Vol. 71, 2000, pp. 76–92.
9. Loraine, R.K. Project Specific Partnering. *Engineering, Construction and Architectural Management,* Vol. 11, 1994, pp. 5–16.
10. Naoum, S. An Overview into the Concept of Partnering. *International Journal of Project Management,* Vol. 211, 2003, pp. 71–76.
11. Uher, T.E. Partnering Performance in Australia. *Journal of Construction Procurement,* Vol. 52, 1999, pp. 163–176.
12. Chen, G., G. Zhang, Y.-M. Xie, and X.-H. Jin. Overview of Alliancing Research and Practice in the Construction Industry. *Architectural Engineering and Design Management,* Vol. 8, No. 2, 2012, pp. 103–119.
13. Scheepbouwer, E., and D.D. Gransberg. Comparative Analysis of New Zealand Alliance Contracting and U.S. Project Delivery Models. Presented at 93rd Annual Meeting of the Transportation Research Board, Washington, D.C., 2014.
14. *Project Alliancing Practitioners' Guide.* Department of Treasury and Finance, Melbourne, Australia, 2006.
15. Ekaterina, O., and P.E. Eriksson. How Procurement Options Influence Risk Management in Construction Projects. *Construction Management and Economics,* Vol. 29, No. 11, 2011, pp. 1149–1158.
16. Gransberg, D.D. Early Contractor Design Involvement to Expedite Delivery of Emergency Highway Projects: Case Studies from Six States. In *Transportation Research Record: Journal of the Transportation Research Board, No. 2347,* Transportation Research Board of the National Academies, Washington, D.C., 2013, pp. 19–26.
17. *In Search of Partnering Excellence.* Special Publication 17(1). Construction Industry Institute, Austin, Tex., 1991.
18. Latham, M. *Constructing the Team.* UK Department of the Environment, London, 1994.
19. Chan, D.W.M., A.P.C. Chan, P.T.I. Lam, and J.M.W. Wong. Identifying the Critical Success Factors for Target Cost Contracts in the Construction Industry. *Journal of Facilities Management,* Vol. 8, No. 3, 2010, pp. 179–201.
20. Davis, P., and P. Love. Alliance Contracting: Adding Value Through Relationship Development. *Engineering, Construction and Architectural Management,* Vol. 18, No. 5, 2011, pp. 444–461.

---

*The Standing Committee on Project Delivery Methods peer-reviewed this paper.*