Early Contractor Involvement (ECI) Construction Project Delivery Methodology for the US Navy

Recent Project Performance,

Review of Implementation from Other Agencies,

Private Sector Performance,

and Recommendations for the Future

Cody N. Robertson

University of Pittsburgh

Joseph M. Katz Graduate School of Business

2022

Executive Summary

It has become widely accepted that contractor involvement early in construction project development can lead to positive outcomes. The traditional construction delivery methods of Design-Build (DB) and Design-Bid-Build (DBB) have been the preferred vehicle for the Navy since the 1980s; meanwhile, the construction industry has actively pursued alternative delivery methods (e.g., Construction Manager at Risk/Early Contractor Involvement and Integrated Project Delivery) to improve construction project performance. The United States Army Corps of Engineers (USACE) has implemented Early Contractor Involvement (ECI) with documented success, and Naval Facilities Engineering Systems Command (NAVFAC) is currently in the early adoption phases with trial projects underway in 4 different geographic regions. These projects are experiencing varying levels of performance because the field does not have experience with this delivery method, and they do not have any guidance or framework to follow. NAVFAC Headquarters intends to send updated guidance to the field offices by May 2022.

This research compared recent NAVFAC ECI project performance with what other agencies and the private sector have experienced. Private sector Construction Manager at Risk (CMR) project performance data was prevalent, easily accessible, and determined to be a relevant source for hypothesizing potential ECI outcomes for NAVFAC. The research found that when compared to DB and DBB, CMR is typically more expensive but carries less variance (risk) with respect to cost growth and schedule growth. This cost/performance tradeoff would be of value to NAVFAC, but only in limited circumstances such as the project requiring unique or "one-of-a-kind" construction means and methods. USACE project performance data did not compare ECI to other project delivery methods, but it did show that ECI was able to deliver cost and time savings when compared to price ceilings and schedule requirements.

This paper then provides a list of recommendations for NAVFAC to consider for implementation into the enterprise-wide ECI guidance. The list can be broken down into actions for Headquarters Consideration, contract management best practices, and team composition best practices. ECI is recommended as a viable project execution methodology for NAVFAC, but only in the limited instances where the project meets the right criteria and the correct resources, training, and additional administrative bandwidth are allocated. If done properly, ECI can prove to be an effective project delivery method for the NAVFAC enterprise.

1. Introduction

NAVFAC is the Naval Shore Facilities, Base Operating Support, and Expeditionary Engineering Systems Command that delivers life-cycle technical and acquisition solutions aligned to the Fleet and Marine Corps Priorities. NAVFAC manages all planning, design, and construction execution of shore facilities for the U.S. Navy. NAVFAC has always utilized DBB as a project execution methodology, and in the 1980s DB was introduced as another tool for construction execution. For 30+ years, these are still the two dominant construction delivery methods utilized to deliver Navy and Marine Corps shore construction (NAVFAC, 2017).

In 2020, the Navy Chief of Civil Engineers directed field offices to execute projects utilizing Early Contractor Involvement. NAVFAC had yet to specify enterprise-wide guidance for how and when to utilize ECI, so each of the field offices has pursued unique approaches. Studying these current projects in tandem with what other federal agencies and the private sector have done has led to insights that may improve project performance, cost growth, and schedule growth. NAVFAC has assembled a working group to deliver enterprise-wide ECI guidance to streamline how these projects are selected and executed with the ultimate goal of delivering the improved value of constructed facilities with American taxpayer dollars.

2. Statement of Research

The scope of this research is to develop recommendations for best practices to incorporate into ECI project planning and execution. Performance on current Navy projects utilizing ECI was examined to determine relevant performance metrics. Interviews were conducted with current Navy teams engaged with ECI to garner lessons learned and best practices. A literature review of ECI project performance, applicability, and utilization across public and private projects was also conducted to inform decision-making. Lastly, Department of Defense and Navy acquisition regulations were reviewed to determine any potential restrictions or limitations to utilizing ECI. Final recommendations were then developed and submitted to the ECI working group for incorporation into the NAVFAC enterprise ECI framework.

3. Definition of Terms

Construction Delivery Method refers to the assignment of responsibilities to the different parties involved in a project to establish a framework of the entire design, procurement , and construction process. The delivery method chosen is a critical success factor in any construction project (Ahmed & El-Sayegh, 2021).

Design-Bid-Build (DBB) is the traditional construction project delivery system in which an architect or engineer collaborates with the customer to develop a complete design, and the customer then solicits bids from construction firms to construct the facility (Carpenter & Bausman, 2016). Using DBB, the owner issues two separate contracts, one with the consultant for the design phase of the project and the other with a construction professional for project execution (Ahmed & El-Sayegh, 2021).

In Design-Build (DB), a single legal entity has the sole responsibility to hire both the consultant and the contractor under one contract representing a single commitment (Ahmed & El-Sayegh, 2021). The DB model creates an opportunity for increased collaboration between the designer and constructor, and DB projects can often be fast-tracked since construction can begin before the design is complete (Hayes, 2014).

Construction Manager at Risk (CRM) is a delivery method in which the construction manager is recruited during the design phase of the project, giving him the responsibilities of both a project coordinator and a general contractor (Ahmed & El-Sayegh, 2021). The CM is "at-risk" because the CM awards the construction contracts, so their profit is at risk if their contractors suffer cost overruns (Choi, Yun, Leite, & Mulva, 2019).

Early Contractor Involvement (ECI) projects are like CMR but are characterized by a preconstruction focus on cost control and constructability with the construction contractor providing a constructability review and estimating (CRE) team during the design process to assist the owner and the designer in developing a high-quality set of construction documents that are designed within the target budget. The design process as a whole mirror that of a DBB project, but with the construction contractor inserted for pre-construction services. The U.S. Army Corps of Engineers (USACE) pioneered this methodology and used it extensively during the Hurricane Katrina reconstruction program (Gransberg, 2016).

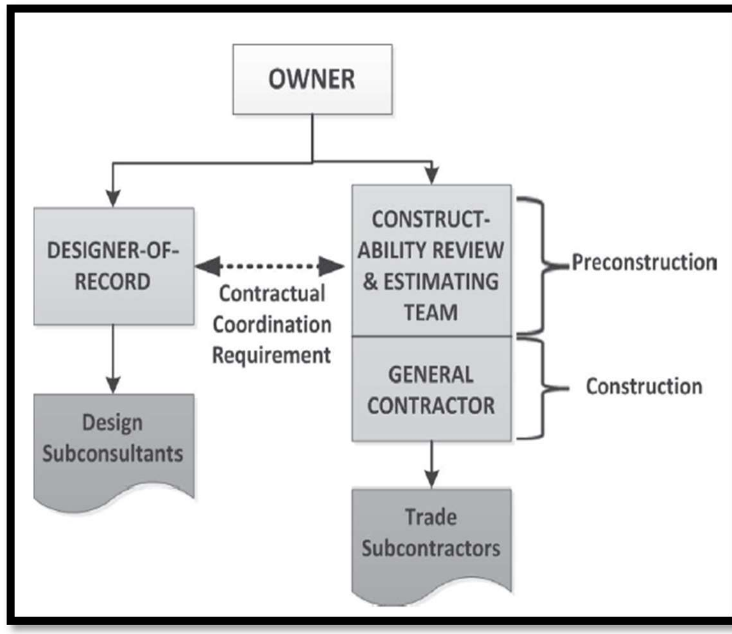


Figure 1 - ECI Project Delivery Method

The NAVFAC ECI working group has defined ECI as a project delivery method that involves a Construction Contractor(s) under a separate contract from the Designer-Of-Record (DOR) during the design phase of the project development. The construction contractor supports the project design development by identifying constructability concerns, advising on means/methods, and sequencing of the works resulting in early mitigation of construction risks for cost and schedule and offering value engineering strategies and innovations for consideration to improve the final delivery of the project.

4. Historical NAVFAC Design-Build and Design-Bid-Build Performance

A recent Navy Civil Engineer Corps (CEC) Officer completed a graduate thesis in which he assessed DBB and DB project performance within NAVFAC. The study focused on completed projects between 2016 and 2021 of comparable size and scope within the Continental United States. Of these seventy-four projects, thirty-five were DBB, and thirty-nine were DB. The baseline for project increases or decreases was measured on the initial project award dollar and time for completion amounts. In comparing the findings in figure 2, DB performed better than DBB in schedule growth, cost growth, and fewer changes per $M (McCorkindale, 2021).

Figure 2 – Project Performance by Delivery Method

		Schedule Growth	Cost Growth	Changes / $M
DB	**Mean**	60%	10%	0.94
	Median	46%	10%	0.53
DBB	**Mean**	84%	17%	2.44
	Median	55%	14%	2.22

(McCorkindale, 2021)

Early collaboration between the designer and the constructor is suspected to be the reason for improved performance on Design-Build projects. Additionally, DB projects can break ground on construction before 100% design completion because there is only one prime contractor. Considering Design-Build's superior performance with respect to schedule growth, cost growth, and changes/$M over Design-Bid-Build, there is a desire to allow for even earlier contractor involvement, hence the interest in alternative delivery methods such as ECI or Integrated Project Delivery (IPD).

5. United States Army Corps of Engineers (USACE) ECI Implementation

USACE defines ECI as an integrated project delivery method that develops a holistic team consisting of the owner, designer, and contractor at the initiation of the project (Gransberg, 2016). USACE has historically used ECI on projects that are complex and/or time-sensitive to complete. These time and technical complexity factors justify the increased administrative costs and staff burdens that are required for successful ECI completion. USACE awards ECI projects using the Federal Acquisition Regulations (FAR) 16.403-2, Fixed Price Incentive Price (Successive Targets) Contracts. Throughout this process, the contractor's qualifications and past performance are based on a go-no-go basis against set criteria. Once a concise list of qualified contractors is formed, the price component is developed. USACE sets the ceiling price based on the authorized funding for the project. Contractors then submit bids with their "initial target price" consisting of their initial target cost and profit. Figure 3 depicts how initial target cost and profit create the initial target price. The target price must be less than the ceiling price, otherwise, the bid is ruled out from consideration.

Figure 3 – Typical USACE ECI bid form (Gransberg, 2016)

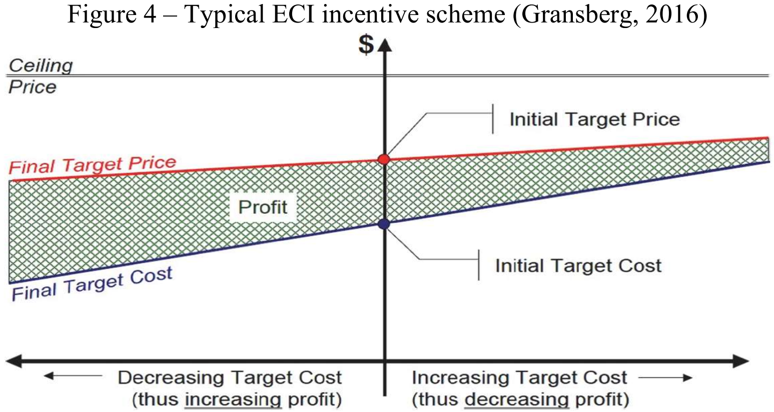
ITEM NO	SUPPLIES/SERVICES	QTY	UNIT	UNIT PRICE	AMOUNT
0001 **BASE**	**Preconstruction Services** (Fixed Firm Price)	1	Lump Sum	$__________	$__________
0002 **OPTION**	**Construction** (Fixed Price Incentive)				
	Initial Target Cost (**ITC**)	1	Lump Sum	$__________	$__________
	Initial Target Profit (**ITP**)				
	% Profit (between a% and b%)		%	________%	
	(ITP = ITC x _____%)	1	Lump Sum	$__________	$__________
					TOTAL (NET) $__________

Initial Target Price

Initial Target Price < Ceiling Price

The awarded contractor provides preconstruction services to include cost estimates and constructability reviews throughout the design phase of the project. When the project nears ~90% completion, the construction option is negotiated and awarded, thereby firming up the price for the entire project. To the greatest extent, the construction option is awarded through Firm Fixed Price, but there are rare times when incentives are incorporated through Fixed Price Incentive (Successive Target) contracts. Figure 4 shows how contractors are incentivized to decrease cost and increase profit, therefore delivering more value to all stakeholders.

Figure 4 – Typical ECI incentive scheme (Gransberg, 2016)



USACE used ECI extensively during the Hurricane Katrina reconstruction program. The results depicted in Figure 5 demonstrate the cost control and savings possible when this project delivery method is applied appropriately. This table shows that while the Final Price was sometimes higher than the Initial Target Price, it was always under the Initial Ceiling Price (total programmed amount). Contractors were often able to complete under the Initial Target Price to enjoy the benefits of increased profits as well. These selected projects reflect an overall 27% apparent savings to the government and demonstrate that if you (1) select the right projects for ECI and (2) properly administer the contracts, there is a possibility for a win-win on both sides.

Figure 5 – Selected USACE ECI Cost Records (Gransberg, 2016)

Project	Type	Location	Initial Target Price ($millions)	Initial Ceiling Price ($millions)	Final Price ($millions)	Savings from Ceiling Price ($millions)
LPV 111	Levee	New Orleans, Louisiana	295	411	342	69
LPV 145	Levee	New Orleans, Louisiana	357	488	237	251
LPV 146	Levee	New Orleans, Louisiana	280	452	272	180
LPV 148	Levee	New Orleans, Louisiana	300	380	350	41
IHNC-01	Levee	New Orleans, Louisiana	154	181	164	17
Tuttle Creek Dam seismic upgrade	Dam	Manhattan, Kansas	206	250	175	75
Central utility plant	Industrial process	Fort Belvoir, Virginia	100	110	107	3
Technology center	Building	Fort Belvoir, Virginia	78	82	72	10
Visitor control center	Building	Fort Belvoir, Virginia	5.8	6.0	5.9	0.1
Parking garage	Building	Fort Belvoir, Virginia	77	78	72	6
Total			1,853	2,438	1,797	652

Rich & Bartha found general themes across multiple USACE projects in which you need to "keep stakeholders aligned and informed, develop and execute training on the model before project initiation, ensure that individuals properly trained and knowledgeable are available to staff the project Partnership Development Team and maintain a high level of management commitment to creating conditions focused on success" (Rich & Bartha, n.d.). These lessons learned and best practices from USACE should be further explored and incorporated into the NAVFAC ECI guidance.

6. Private Sector Construction Manager at Risk (CMR) Performance

ECI differs distinctly from private sector CRM due to requirements from the Federal Acquisitions Regulations (FAR). Most notably, the FAR requires price to be a factor in source selection. CMR projects are often awarded entirely based upon technical factors or with little emphasis placed on price. CMR projects utilize a Guaranteed Maximum Price clause while ECI contracts utilize FAR 16.403-1(a) to include a ceiling price (FAR 16.403-1(a), 2019). With CMR, value engineering is present in design and construction as a profit incentive for the contractor to improve product delivery; meanwhile, engineering profit incentive is only present during the design phase of ECI projects where contracts award the construction option as a FFP because FAR 36.297 states that "generally, firm-fixed-price contracts shall be used to acquire construction." Lastly, in most CMR projects, the contractor carries a contingency to manage small scope changes, but with ECI the government maintains the contingency.

The past performance of CMR in private sector construction is well documented in comparison to other project delivery methods. Although CRM and ECI differ, the desired project benefits are similar, making the performance of CMR is relevant to study. Proponents of CMR often cite cost and schedule reductions as a benefit of ECI, but a study of public-school construction done found that the largest benefit of CMR is the quality and satisfaction of the project (Carpenter & Bausman, 2016). This 2-year study analyzed the construction of 137 schools in the Southeastern United

States which used DBB or CMR. Figures 6 and 7 show that while CMR performs better concerning cost and schedule growth (control), the overall cost is higher with CMR. The data also reveals that CMR has better cost and schedule predictability. When it came to construction product quality, construction team service quality, design team service quality, and project team service quality, disputes, claims, and warranty calls, CMR was better than DBB by wide margins. The conclusions of this study reveal that the cost performance of DBB was significantly superior to CMR, but CMR outperforms DBB in schedule control, cost control, quality performance, and service quality performance.

Figure 6 – Cost Comparison DBB and CMR (Carpenter & Bausman, 2016)

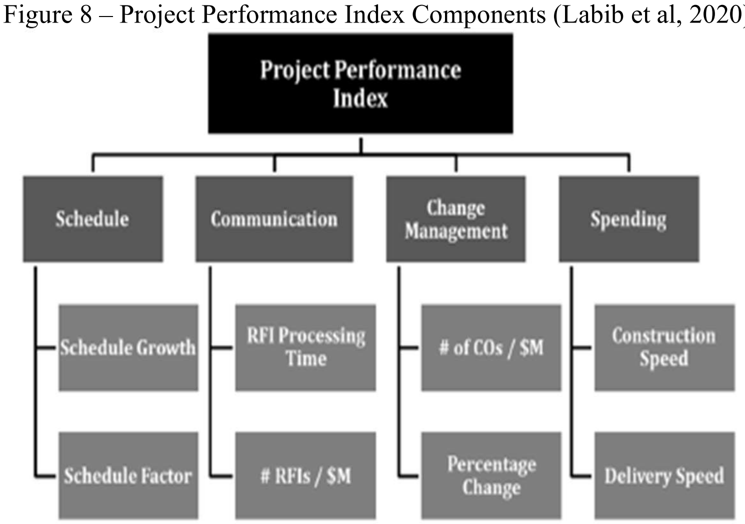
Metric	Design-Bid-Build	CM at Risk	Difference	Percentage	*P*-Value
Original construction ($)	$20,960,467	$26,001,207	($5,040,740)	−24.05	0.0148
Final construct cost ($)	$21,280,286	$26,101,221	($4,820,935)	−22.65	0.0230
Original project cost ($)	$22,023,229	$27,141,092	($5,117,863)	−23.24	0.0180
Final project cost ($)	$22,427,554	$27,436,298	($5,008,744)	−22.33	0.0250
Unit cost ($/m^2)	$148.80	$191.60	($43)	−28.76	<0.0001
Student cost ($/student)	$20,915.60	$27,057.00	($6,141)	−29.36	<0.0001
Construction cost growth (%)	1.25%	0.32%	0.93%	74.40	0.2249
Project cost growth (%)	1.45%	1.04%	0.41%	28.28	0.6004

Figure 7 – Schedule Comparison DBB and CMR (Carpenter & Bausman, 2016)

Metric	Design-Bid-Build	CM at Risk	Difference	Percentage	*P*-Value
Actual construction (days)	569.00	564.70	4.30	0.76	0.8930
Actual project (days)	1,023.60	1,008.30	15.30	1.49	0.8250
Construction schedule growth (%)	15.58%	12.41%	3.17%	20.35	0.4868
Project schedule growth (%)	8.11%	6.52%	1.59%	19.61	0.4760
Project intensity (m^2/day)	14.74	14.18	0.57	3.84	0.6084
Project intensity ($/day)	$22,924.90	$28,784.40	($5,859.50)	−25.56	0.0033

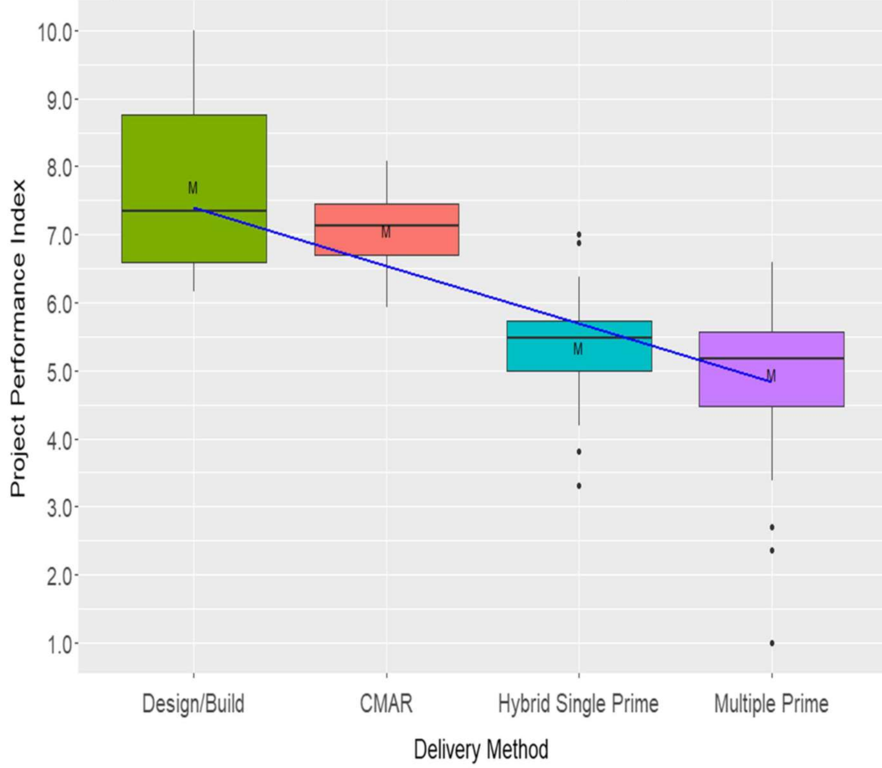
A more recent study conducted by Labib, Lotfallah, Hannah, and Boulos developed a Project Performance Index (PPI) shown in Figure 7 to compare traditional (single and multiple prime) project methodologies with alternative (Design-Build and Construction Manager at Risk) methodologies. The multivariate PPI quantitatively analyzes schedule, communication, change management, and spending across different methodologies.

Figure 8 – Project Performance Index Components (Labib et al, 2020)



In analyzing Figure 9, DB scored the highest mean PPI at 7.6, followed by CMR at 7.1. The two traditional methodologies scored at 5.3 and 4.9. DB also has the highest standard deviation of 1.2 in comparison to .7 for CMR. The data clearly show that DB and CMR can, on average, conform to a planned schedule, encourage communication, increase collaboration, reduce changes, and deliver better projects better than the two traditional methodologies. The data show that while DB experienced the highest performance, it also had the highest variance, which translates to greater risk compared with the other methodologies. CMR performed comparably with DB, but with better predictability.

Figure 9 – Project Performance Index against different delivery methods (Labib et al, 2020)



Franz, Molenar, and Roberts compared 212 projects using DB, DBB, and CMR as a delivery method. This study confirmed results (Figure 10) from a 1998 study by Konchar and Sanvido which showed DB as the superior delivery method for unit cost, cost growth, and schedule growth. While DB remained the superior methodology, the gap between the performance of all methodologies is narrowing. This is suspected to be due to the growing consensus on best practices for execution and blurring/hybridization of project methodologies (Franz, Molenar & Roberts, 2020). The research also suggests that as the construction industry's knowledge of best practices and success factors increases, project owners can apply these with favorable effects regardless of the project delivery method. Improved team chemistry, early partnering, and clear succession planning all has a positive effect on the final product. Franz et al found that "projects that involved both the designer and builder in early goal setting had reduced schedule growth. Our findings provide further evidence that the project delivery system is not the sole contributor to project performance and these human-related factors are, in some cases, equally as important" (Franz, Molenar & Roberts, 2020).

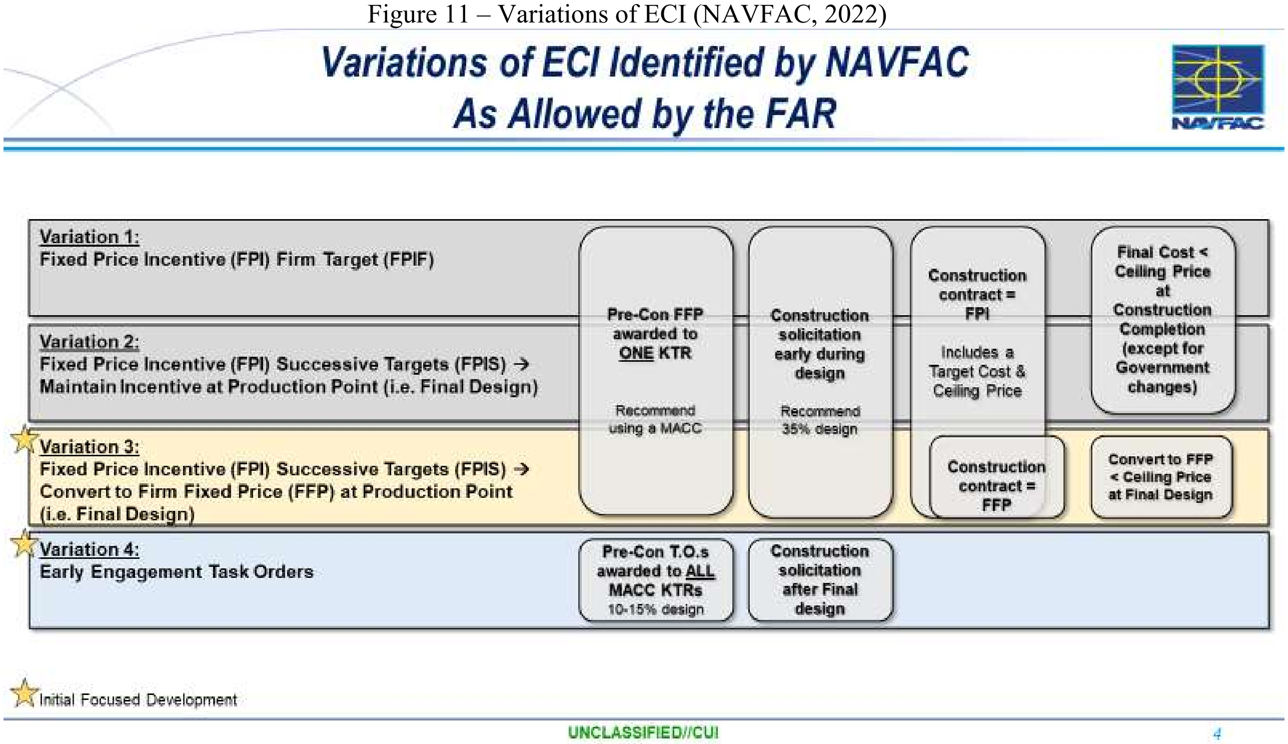
Figure 10 - Comparison of multiple project delivery methods (Franz, Molenar & Roberts, 2020)

Performance measure	Konchar and Sanvido (1998) DB versus CMR (%)	CMR versus DBB (%)	DB versus DBB (%)	R^2	This study DB versus CMR (%)	CMR versus DBB (%)	DB versus DBB (%)	R^2
Unit cost	4.5 less	1.5 less	6 less	99	1.9 less	1.6 more	0.3 less	99
Cost growth	12.6 less	7.8 more	5.2 less	24	2.4 less	1.4 less	3.8 less	21
Schedule growth	2.2 less	9.2 less	11.4 less	24	3.9 less	2.2 more	1.7 less	21
Construction speed	7 faster	6 faster	12 faster	89	13 faster	20 faster	36 faster	88
Delivery speed	23 faster	13 faster	33 faster	87	61 faster	25 faster	102 faster	89

7. Naval Facilities Engineering Systems Command ECI Implementation (to date)

To date, NAVFAC has ECI projects ongoing in the Mid-Atlantic, Southeast, Southwest, and Pacific geographic regions. The only one nearing completion is NAVFAC Mid-Atlantic's P-1120 Maritime Skills Training Center which is scheduled for completion in March 2022. To spark interest and quickly capture feedback from ECI, the enterprise directed field offices to execute projects using the methodology without first establishing a framework or guide. The ECI working group has formulated four (4) potential variations for the execution of ECI projects as outlined in Figure 11. The projects currently being executed align most closely with variation 3 and variation 4. The initial working group consensus is that the enterprise will most often seek to implement Variation 3 because it most closely aligns with what USACE currently practices with success, but the other variations possess qualities that would situationally make them the more desirable option. By further developing, defining, and delineating the benefits and risks of each variation, NAVFAC can give the field offices a valuable decision-making tool.

Figure 11 – Variations of ECI (NAVFAC, 2022)



As a part of this research, interviews were conducted with all field offices to gather consolidated lessons learned and best practices to date, but since most projects are still in the initial stages, the findings are limited and should be revisited once projects are complete. More importantly, the results of these early-phase projects should be considered separate from the rollout of the ECI pilot projects once the NAVFAC enterprise formalizes the enterprise ECI guidance. Nevertheless, common themes from current projects are outlined below:

- *Early ECI Contract Award*. The P-1120 project did not get the ECI contractor under contract until the ~50% design stage. This project experienced redesign delays that could have potentially been avoided if the contract had been established sooner to receive earlier contractor input. This lesson has been implemented in other regions, and the contracts were typically awarded before the ~35% design stage. Field offices expressed how project complexity, size, funding source, location, and timelines have an impact on when the ECI contract can/should be awarded, but most agreed that awarding past the 35% design negates the benefit of ECI. This finding is consistent with recommendations found throughout the literature review.
- *Communication and Planning.* If ECI will be the chosen project delivery method, it should be decided early enough to include the cost in the PDA effort. The government project manager and design manager should be selected with great care to ensure they have the skillset and capacity for the additional administrative oversight required for ECI execution. The project managers currently executing ECI projects have cited the additional effort required to foster collaboration amongst the Architect-Engineer team, ECI contractor team, the facility owner, and the government team. Feedback from the P-1120 project contractors indicated a need for standardization of cost estimates and design package review formats. These administrative requirements need to be established during acquisition planning and communicated consistently throughout the project. Project feedback also indicated that fast-tracking construction was not discussed early enough. If an early construction start is being considered, the government PM and construction management team should specify this early, and should be a topic of conversation at each meeting.
- *Solicitation Specificity.* The acquisition plan and solicitation should clearly articulate the reasons for opting to use ECI as well as the requirements for the Architect-Engineer and the ECI contractor. These should include the frequency of meetings, the required attendees, and required deliverables due at each design phase iteration. This specificity ensures that expectations are clear from all parties at the project outset.
- *Training.* Aside from independent ECI research, none of the current NAVFAC staff has been trained or given guidance on how to administer an ECI contract. This has led to varying levels of performance. To achieve the potential benefits of an ECI contract, the government execution staff needs training.
- *Ceiling Price.* Several projects proceeded without a ceiling price in place. This leaves the government vulnerable to an escalation of price and does not give any meaningful cost risk to the contractor. Most projects followed the target cost and profit model, but not all have incorporated and communicated the maximum ceiling price. Recommendations regarding the ceiling price are included in section 8 of this paper.
- *Project Selection.* The NAVFAC ECI working group has defined several criteria that should be met for ECI projects including complex means and methods of construction, “one of a kind” projects, potential constructability issues, or high risk for post-award cost/schedule growth. Some of the current ECI projects meet these criteria better than others, so the criteria need to

be further developed and shared with the field so that projects that will benefit most from ECI are selected. This topic is currently being investigated by another Civil Engineer Corps Officer for graduate study.

8. Challenges with ECI

As with any project delivery method, there are challenges that are presented with ECI. Since NAVFAC has little experience with alternative delivery methods, ECI adoption requires the staff to be properly trained. The research found that in many cases the contractor and designer may have different agendas (Gransberg, 2016). This adds a burden to the government project management team to ensure project goals are clearly stated and followed by all contributing members. ECI adoption also demands a shift in procurement culture that might make some program managers uneasy. The total cost of the project is not known until the construction price becomes fixed. This is a risk that the government must accept to properly execute ECI.

Pursuing ECI could also potentially narrow the range of competitive contractors. In most cases, the government desires a contractor with demonstrated success in ECI. This makes ECI projects a de-facto closed-loop system, which could be considered a drawback by many. Lastly, depending on project complexity, contractors may be stressed to develop accurate Initial Target Costs at the early stages of design as ECI requires. This leads to the possibility of contractors over or under bidding based on the level of uncertainty/risk they perceive.

9. Recommendations and ECI Success Factors

Based on the literature review, past performance of USACE ECI projects, and interviews with the field, there are projects within the NAVFAC enterprise that would benefit from ECI. Projects that require technologically advanced construction means and methods, require superior final product quality or pose a significant risk of cost/schedule growth make good candidates for ECI execution. Based on the historical performance of current NAVFAC methodologies, DB would be the best current delivery method for these projects, but research showed that there is greater variance, and therefore risk, in project outcomes with DB execution, making ECI a more reliable option (Labib et al, 2020).

Here is a list of recommendations for NAVFAC to consider for ECI contracts:

- *Codify the NAVFAC Enterprise Working Group:* The current NAVFAC ECI working group is a collateral duty for all members, including the team leaders. The team has done well to date, but to ensure the effectiveness of the ECI rollout across the enterprise, NAVFAC needs to make this team a primary duty so that the initial rollout, pilot program, and any iterative changes are managed by a dedicated team.
- *Determine ECI measures of success* and keep track of them for all projects. Initial feedback from the field offices and the working group suggest that the enterprise should focus on cost growth, schedule growth, amount of request for information (RFIs), number of contract change orders (both quantity and cost), number of claims (both quantity and cost), perceived level of partnering from govt and contractor perspectives, and the amount of warranty or defect issues. Each of these criteria should be quantified and baselined so that every ECI project can be measured from the same key performance indicators. Large variances in any

of these performance indicators will signal that there is room for process or control improvements.

- *Award ECI contracts early*: An industry survey found that the most influential factor in ECI success was getting the contractor involved early enough so that they can deliver value at the early stages of design and mitigate future risks (Wondimu et al, 2016). With the complexity of projects that NAVFAC is aiming to use ECI on, the contractor should be onboarded in the 20-35% design stage. Each project should be considered independently, but generally, the more complex the project, the earlier the contractor should be involved. This will mitigate excess bureaucracy and expense, but also allow for sufficient influence.
- *Government Project Team ECI Experience*: Staffing and managing an ECI contract requires a different knowledge set than traditional DBB or DB firm-fixed-price contracts. NAVFAC should create a training course and require any ECI project team member to take that course before being assigned an ECI project. Once an employee demonstrates proficiency with ECI, every effort to incorporate them into future ECI projects should be made. Ongoing ECI training in addition to the initial familiarization course would be warranted for members who continually work on ECI projects.
- *Maintain Continuity Amongst Stakeholder Team:* Turnover of government construction management teams is common in NAVFAC. Active-duty military and civilians fill the roles of construction managers and engineering technicians during the construction phase. Competing requirements and resource limitations often lead to project team adjustments. With early partnering and collaboration with the contractor being a major goal and benefit of ECI, NAVFAC should maintain the continuity of the entire government team throughout the life of the project. The contractor team should likewise make every best effort to reduce the turnover of team members. Continuity of the project team builds trust, improves communication, and fosters a more collaborative team environment. This in turn improves the overall likelihood of project success and improved final product quality.
- *Qualifications of the Contractor*: The contractor must have prior success with ECI projects to be considered for contract award. Prior success could include project performance on government ECI projects or CMR projects in the private sector. This and other non-price technical factors should be weighed on a “go-no go” scale to ensure that the competitive list of contractors is qualified and able to contribute as soon as the contract is awarded.
- *Shared Risk*: Fair distribution of risk throughout the life of a contract keeps all parties engaged and minimizes the chance of adversarial relationships in the execution phase. The compensation package for the project should sufficiently match the level of risk the contractor is taking. In most situations, a Fixed Price Incentive Successive Targets (FPIS) contract for pre-construction services and a conversion to a Firm Fixed Price (FFP) contract for construction will be sufficient. In rare and exceptionally complex or constrained conditions, the profit incentive could be carried out through the construction phase, if warranted. In all situations, a ceiling price shall be in place to protect the government.
- *Ceiling Price*: FAR 16.403(a) states that “A fixed-price incentive (firm target) contract specifies a target cost, a target profit, a price ceiling (but not a profit ceiling or floor), and a profit adjustment formula. These elements are all negotiated at the outset. The price ceiling is the maximum that may be paid to the contractor, except for any adjustment under other contract clauses” (FAR 16.403-1(a), 2019). Final costs for these projects are determined by applying the profit adjustment formula to determine the profit by accounting for the final target price in comparison to the final project price. The price ceiling may be specified by the government

during solicitation or proposed by the contractor with their proposals. It is recommended that the government provides the profit ceiling when it perceives higher risk or degrees of uncertainty. For less complex or further defined projects, the government should consider requesting the price ceiling from bidders during solicitation. This leads to a greater likelihood of cost savings for the government.

- *Fast-Track Construction:* Fast-tracking is starting construction before the completion of the 100% design. This is often in the form of contractor mobilization of equipment, earthwork, and preliminary civil activities. Due to the increased contractor involvement and collaboration during the preliminary stages of design, ECI projects are ideal candidates for fast-tracking. If fast-tracking is an available consideration, NAVFAC should include this in the solicitation, and require detailed construction phasing at each design iteration. These requirements need to be written into project solicitation so that contractors are aware that fast-tracking is encouraged. Contractors with successful histories during fast-tracked projects should be looked upon favorably during source selection. Early and aggressive communication with facility occupants, the Architect-Engineer, and the contractor make fast-tracking possible.
- *Create Collaborative Decision-Making Environment:* Early partnering and teaming amongst all parties allows the group to develop a sense of ownership and commitment to the project. A "problem-solving culture" should be established at the project outset vice a "blame culture" (Khalfman, McDermott & Swan, 2007). NAVFAC can foster this culture by ensuring planning and decision-making happen in a room with all parties co-located. NAVFAC design and construction managers must closely coordinate with all stakeholders from project inception to completion at a pace that is more frequent than DBB or DB projects. The project manager should facilitate this collaborative decision-making environment during the preconstruction phase and this responsibility should transition to the construction manager once construction starts.
- *Joint Project Goals*: A key component of another alternative delivery method, the Integrated Project Delivery method, is the development of joint project goals. This could easily be incorporated into NAVFAC ECI projects. Following the ECI contract award, the team consisting of all stakeholders should dedicate a stand-alone meeting to generate specific, measurable, attainable, relevant, and time-bound (SMART) goals. Generating the goals as a team encourages ownership and solidifies partnerships. Once established, goals should be measured and benchmarked at each pursuant meeting. This allows the joint celebration of achievements and collaborative problem-solving where there are shortcomings.
- *Obtain maximum benefit from pre-construction services*: Management of an ECI contract during the construction phase should not significantly differ from current practices, but there is more management effort required during the design/pre-construction phase. During pre-construction, the government project manager (PM) or design manager (DM) needs to be the orchestrator of collaboration and communication amongst all parties. They should track progress towards shared goals, ensure all voices are heard, and continually push the team forward. PMs and DMs do this under traditional DB and DBB methods, but it needs to be at a much higher rate for an ECI project. For this reason, NAVFAC should select PMs and DMs carefully for ECI projects and resource-level workloads to ensure that they have adequate capacity for the additional requirements these projects demand. NAVFAC leaders may be hesitant to allocate extra time and effort in comparison to traditional DB and DBB contract management, but research has shown that the benefit of partnering far outweighs the cost of partnering itself (Song, Mohamed & Abourizk, 2009). Major design review meetings should

incorporate the construction management team so that they can build rapport with the Architect-Engineer and Contractor. This shared history and trust amongst all stakeholders will help the team overcome the issues that arise during the construction phase.

- *Create Feedback Rich Environment*: Feedback and open communication between all stakeholders throughout the project are especially important for ECI projects. Nahyan et al found that the planning and design stages of construction have the greatest potential to significantly impact project completion and outcomes (Nahyan et al, 2019). Feedback from the P-1120 project suggested that the contractor did not have access to make comments through Dr. Checks and Projnet alongside the Architect-Engineer. Technological inefficiencies like this will prevent NAVFAC from capturing the greatest benefits of ECI. NAVFAC's current knowledge-sharing systems should be re-evaluated to ensure they are adequate for the collaboration and knowledge sharing necessary for an ECI project. Best practices and systems from industry leaders should be evaluated and procured to ensure that information sharing is prioritized, especially during the pre-construction phase. A feedback-rich environment will allow the benefits of ECI to occur.
- *Trust*: Trust is a fundamental success factor for any construction project, and it is an indispensable element of the ECI methodology. The two most critical factors for cultivating trust are performing competently and open and effective communication (permeability) (Wong, Cheung & Ho, 2005). According to Wong, Cheung & Ho, "Performance is evaluated by the problem-solving ability and competence of work. Permeability is often assessed by the effectiveness and efficiency of the communication between the construction partners." The same study by Wong et al found that trusting moves on behalf of the contractor has a significant correlation with the trustworthiness of them as perceived by the project owner/manager. Once trusting moves start, they are also much more likely to continue into trusting loops. NAVFAC needs to instill and verbally reiterate trust in the contractor at contract award. By demonstrating competence in contract administration and communicating openly early in the contract, trust cycles are more likely to ensue. Continued demonstrations of competence, consistent and timely feedback from both parties, and fluid communications will cultivate the trust necessary for a successful project. ECI allows this "trust cycle" to start early and continue to project completion.
- *Continued Analysis of Construction Methodologies*: Historical data to compare different project delivery methodologies and outcomes is not readily available to everyone within the NAVFAC enterprise. NAVFAC should invest in technologies that give program managers the ability to compare historical project performance based on geographic location, project type, size, cost, delivery method, customer type, and any other definable features. Other relevant historical project performance data such as the number of RFIs, warranty claims, latent defects, or requests for equitable adjustment should be collected and archived as well. This tool would be invaluable for the enterprise moving forward to assist project planners and executors in making the best decisions for each respective project based on quantifiable and meaningful data.

10. Conclusion

Analysis of USACE ECI project performance demonstrates that this methodology can be successfully implemented on federal construction projects. Private sector CMR project performance demonstrates that CMR performs better than DBB and similarly to DB in terms of cost and schedule growth. CMR was also proven to have high final product quality with a low level of variance, making it a viable candidate for complex and risky projects. Project planners should be aware that the increased fidelity in cost/schedule growth and improved final product quality an ECI project can experience usually comes at a greater overall cost. There are projects within the NAVFAC enterprise that would benefit from this tradeoff, but they should be selected with an elevated level of scrutiny to ensure that ECI is the best fit. Full implementation of ECI on NAVFAC projects is recommended with program management conducted by the ECI working group.

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