ALTERNATIVE TECHNICAL CONCEPTS FOR CONTRACT DELIVERY METHODS IN ACCELERATED BRIDGE CONSTRUCTION

Quarterly Progress Report
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1 Background and Introduction

Accelerated bridge construction (ABC) is known to reduce the construction time and traffic disruption drastically, yet there are several issues in its delivery methods that have yet to be fully investigated. It is vital to provide specific frameworks and guidelines for ABC projects, which disseminates knowledge to encourage ABC stakeholders to understand the various contract delivery methods that promise possible savings on a project's cost and schedule. This study aims to address one effective contract delivery methods, by highlighting and providing a metric that supports ABC stakeholders and contractors recognize the merits of using Alternative Technical Concepts (ATC) on ABC projects. ATC is an effective project delivery method which is achieved through early contractor involvement, thus encouraging early understanding of the project, reducing risks proposing materials and modifications to contract requirements before the bidding or proposal process. That said, employing ABC projects with ATC contract method not only will reduce traffic and travelers' disturbances, but also reduces ABC's contract duration and cost by avoiding change orders as well as eliminating uncertainties within ABC projects. To be able to achieve this goal and showcase to ABC stakeholders the advantages of ATC, the first step will be to conduct a rigorous literature review to understand the status of contract delivery methods in ABC projects and identify any potential case studies with ATC methods. Then a focus group/interview to professionals from construction, transportation, and the structural disciplines will be conducted to develop decision criteria that are usually used in the analysis of analytical hierarchical process (AHP). Afterwards, a semi-structured survey to representative samples of ABC stakeholders will be conducted to validate the hierarchical decision criteria developed through the focus group discussions/interviews. The obtained results from the survey are also used to develop a binary logistic regression model to determine the benefits of using ATC specifically on time/schedule in ABC projects. The findings of the study foster the development of a streamlined procedure for effective adoption of ATC, which would surely expedite ABC projects' delivery, eliminate uncertainties about the ATC as a contract delivery method for ABC projects, and provide a framework to support early contractor involvement when ATC is adopted thus advance the frontier of ABC.

2 Problem Statement

There are clear benefits to early contractor involvement in Accelerated Bridge Construction (ABC) projects. Alternative Technical Concepts (ATC) is one method of early contractor involvement allowing them to propose modifications to contract requirements before the bidding or proposal process. Past studies have investigated the cost savings gained by using ATC. The proposed project would focus on the construction time savings realized when ATC is used on ABC projects. ABC is an effective methodology that eliminates disruption of traffic and reduces safety hazards and public nuisance. To achieve this, ABC technique implements innovative technologies during the replacement of a deteriorating bridge or constructing a new one. Even though this technique has been regarded as an effective method for reducing overall construction time besides avoiding traffic disruption, there are some risks involved in accelerated constraints indicated in this method. First, there is a growing concern for elevated costs incurred by ABC method in a project. Similarly, lack of standardization, inexperienced contractors and manufacturers and technical problems related to its strength and long-term performance are some of the major issues in this methodology (Ofili 2015). Past studies have investigated the gain in cost savings when

using Alternative Technical Concepts (ATC). ATC is an effective project delivery method which is achieved through early contractor involvement, allowing them to propose modifications to contract requirements before the bidding or proposal process. The proposed project would focus on the construction time savings realized when ATC is used on ABC projects. Therefore, this study will also be geared towards addressing these issues in ABC method by fully embracing the benefits offered by ATC.

3 Objectives and Research Approach

The proposed research project will be geared towards determining the factors which impact the integration of ATC in ABC projects through the analytic hierarchy process (AHP). The objective of conducting this analysis is to develop a hierarchical model that can be used to develop a guideline for effective adoption of ATC thus expediting the contract delivery. These streamlined procedures for ATC would aid to successfully accelerate the design, construction process and procurement of infrastructure assets for either rehabilitation or new projects related to ABC. The integration of ATC in ABC projects not only ensure smooth regulation of traffic and adequate safety but more importantly address the issues of elevated cost and delay in project schedule. One of the main motivations of this study is to fulfill the literature gap by providing a separate ATC guide that is specific to ABC. One very effective example that supports the fact that ABC projects need their own tailored ATC guidelines is the Construction Industry Institute (CII) tools that are dedicated to each project type (infrastructure, residential, industrial, medical etc..). CII, provided each project type with an individually tailored tool to determine its particular associated risks which in turn ensure supporting each specific project type (ElZomor 2017). That said and because one of major issues in ABC is lack of standardization that impedes the mass production of modules, this approach would foster the development of a separate tailored ATC guide, which is specific to ABC thus would further facilitate the required standardization. Another main goal of the study is also to develop a linear regression model that evaluates the influence of ATC adoption on the construction time savings particularly for ABC project.

3.1 Summary of Project Activities

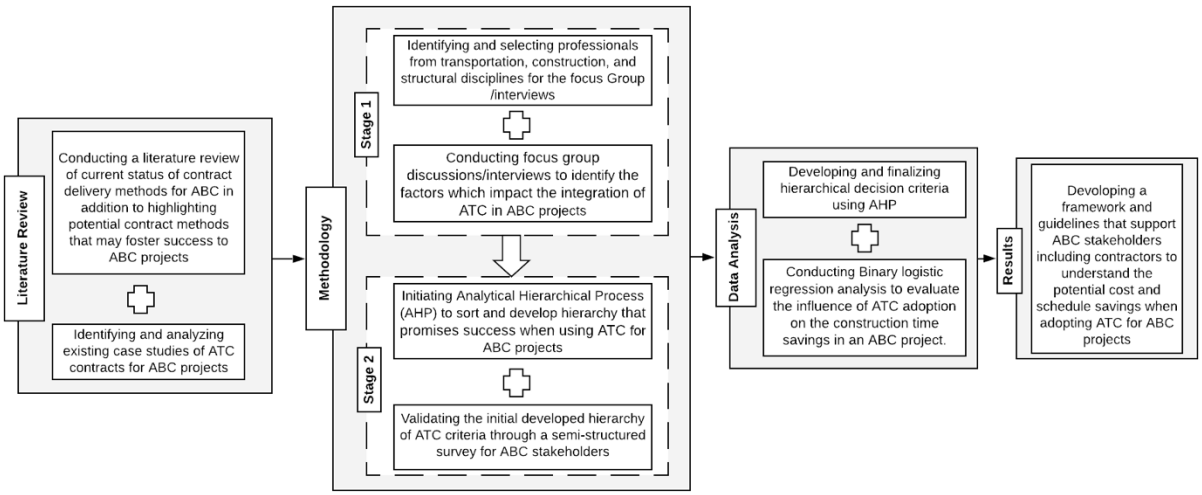

Figure 1: Overview of Project Activities and their Sequence

4 Description of Research Project Tasks

To date the Task One, literature review, has been partially completed.

Task 1 – Literature Review

Proposed task description: conducting a Literature Review.

Description of work performed up to this period is encompassed in the below set of paragraphs.

The objective of the first task is to understand the current status of contract delivery methods for Accelerated Bridge Construction (ABC) in addition to highlighting potential methods that may foster success in ABC projects. ABC is an innovative bridge construction technique consisting of effective plans, high performance materials, safe designs, and cost-effective construction methods for reducing the overall construction time of new bridges or rehabilitation of existing bridges (Phares and Cronin 2015). Since faster delivery of projects with reduced congestion and safe execution is a top priority in the industry, many bridge construction projects are gradually adopting this technique to achieve this objective (Khaleghi et al. 2012). Ofili (2015) indicated that ABC techniques that have been used for several years in the past mainly focused on prefabricating bridge elements for constructing or renovating a bridge. It is only in the recent years that the extensive use of this technique is currently being scrutinized and several new discoveries are being made (Zhu and Ma 2010). Although ABC has been found to reduce the bridges' overall construction time, recent studies indicate that there are several issues associated with its delivery method (MDOT 2015). Some of these major issues include high initial cost of ABC, lack of standardization, inexperienced contractors and manufacturers etc., which have impeded its mass adoption (Saeedi et al. 2013). To this end, there is an inevitability to identify the most effective delivery method for ABC projects that promises controllability and reduction of construction schedules. Thus, this will initiate an opportunity to replace a large number of our deteriorating bridges with minimum traffic disruption, reduction in the environmental impacts and guaranteeing improved worker safety (Jia et al. 2018).

Gransberg (2013) highlighted that projects in Florida, Maine, Minnesota, Missouri, New York, and Utah utilized design-bid-build (DBB), construction manager-general contractor (CMGC), indefinite-delivery and indefinite quantity (IDIQ) and design-build (DB) contracts to expedite the procurement process and restore the infrastructure systems. Rouhana and Hamzeh (2016) indicated that quality assurance and acceleration of project delivery are most effectively achieved in design-build setting where the management of the design, as well as construction, is mostly controlled by the contractor. The CMGC model also integrates construction contractors into the design phase by using the contract of preconstruction services, but a DBB contract doesn't integrate such provisions (West et al. 2012). In fact, DBB often constraints innovation, leads to high cost, time growth and seldom provide the best value to the owner (Stutz 2000). Focusing on ABC projects where their contractual and design agreements usually include preconstruction activities, which generally include prefabricated elements that require effective and well-planned procurement strategies. Therefore to ensure the delivery and manufacturing of such long lead items for ABC projects, it is imperative to hold early meetings between the construction stakeholders (i.e., owners,

contractors engineers, consultants, suppliers, etc.); as well ensuring early clearance and permitting associated with environmental cases for ABC projects (Khaleghi et al. 2012). To this end, the early contractor's involvement not only encourages the adoption of ABC projects but also guarantees the success of such complex projects, which in turn prerequisites a special contract method that supports early contractors' involvement.

In recent years, there is a growing interest in incorporating Alternative Technical Concepts (ATC) on DBB projects such that early contractor involvement for achieving integrated project delivery on conventional low bid projects is possible (Gransberg 2014). ATC is one of the methods of early contractor involvement allowing them to propose modifications to contract requirements before the bidding or proposal process (Mattox 2019). Since ATC fosters alteration in baseline design and provides potential design solutions to complex design problems, its usage has been successfully integrated in different types of project delivery methods (Gransberg 2014). Regardless of the aforementioned advantages of ATC, such a contract delivery method is not frequently used in ABC projects as there aren't yet guidelines which provide streamlined procedure to embrace ATC in ABC projects.

As many states are adopting ABC to upgrade the functionally obsolete or structurally deficient bridges across the United States, an innovative contract delivery method is necessary to improve the ABC decision-making process and expedite project delivery. For effective decision making in ABC, tools have also been developed which have helped to plan alternatives in the early stages by preventing costly investments (Saeedi et al. 2013). ElZomor et al. (2018) also highlighted that tools such as Project Definition Rating Index (PDRI) have been found to be effective for assisting in front end planning efforts for small as well as large infrastructure project thereby, facilitating the assessment of risks and defining of infrastructure projects. However, these tools do not facilitate effective contract delivery, but rather focus on planning, alignment and in the design stages. Therefore, there is an opportunity to exploit the benefits of ATC in ABC projects to expedite project delivery through the most economical design, which is achieved through early contractor involvement. Besides, the ATC technique not only maximizes opportunities for contractor innovations (i.e. means and methods) but also enhances constructability (Gransberg 2014). This creates possibilities for cost reduction and effective design solutions. Another advantage is that it helps to gain control over as well as accelerate the procurement of design and construction assets and the project delivery time (Mattox 2019). Gransberg et al. (2014) developed NCHRP Synthesis 455 (Alternative Technical Concepts for Contract Delivery Methods) which was completed in 2014. This synthesis project included a detailed literature review, DOT survey, and case study of nine projects from different states. The project was focused on contractual variances and its challenges as well as determining the cost and schedule savings when including ATC.

There are several contract delivery methods that may be adopted in ABC projects, yet for example, Build operate and transfer (BOT) postures uncertainties and risks associated with such delivery methods due to existence of several complexities in projects (Ebrahimnejad et al. 2010). Despite lowering the role of government in the BOT project and increasing private investments, BOT poses

threat to project delivery in terms of legal, technical, construction, social, and economic risks among others (Kumaraswamy and Morris 2002). Mesa et al. (2016) highlighted that integrated project delivery (IPD) is an emerging delivery system with minimum risks and is known to improve supply chain integration in complex building projects. Although the project delivery method like IPD had a positive impact on mega projects, construction stakeholders seldom comprehended the effectiveness of such method in projects (Matthews and Howell 2005). The major feature that facilitates IPDs' effective project delivery is early collaboration of key project stakeholders which eventually helps meet owners' performance expectations (Hanna 2016). Gransberg et al. (2014) indicated that ATC is one of the integrated project delivery method which bolsters competitiveness during bidding process which ultimately helps meet or even exceed the performance expectations of owners. Despite that contractors usually aspire to reduce bid costs in infrastructure projects without consideration of contract methods, impacts to travelers and disturbance of traffic (Saeedi et al. 2013), this study challenges this concept by emphasizing the cost and schedule saving associated with ATC for ABC projects as well as highlighting and providing a metric to support contractor realize the merits of using ATC on an ABC projects. Thus, there is an emerging need for a contractual framework for ABC projects that not only ensure last longing bridges, but also deliver ABC projects quicker, safer, cheaper and more innovative.

Task 2 – Data Collection

Proposed task description:

The study will identify stakeholders from the professional of academic setting in the disciplines of transportation, construction and structural whom possess knowledge about ABC projects. Only those stakeholders who are involved in the Accelerated Bridge Construction (ABC)-University Transportation Center (UTC) research project will be selected for focus group/interviews as the diverse set of expertise in this research group would help to advance the frontier of ABC. After selecting these stakeholders, a focus group/interviews will be held. Through focus group/interview discussions, benefits and factors affecting the integration of Alternative Technical Concepts (ATC) in ABC projects will be identified by those experts. Afterwards, a survey questionnaire will be prepared to arrange all the factors/criteria in a hierarchy, which provides an overall view of the relationship among the factors. This survey will be used to validate the focus group/interview discussions by other ABC stakeholders. This would eventually assist in preparing an agreed upon guide specific for ABC stakeholders, which pledges to expedite contract delivery in ABC projects. The first and most challenging process in AHP is essentially the identification of decision criteria. Then, focus group/interview will discuss mutually exclusive categories and create a hierarchy of criteria that are used during the analysis of analytic hierarchy process. These criteria within the created hierarchy are homogenous at each level and indicate a similar level of specificity. The hierarchy includes two levels where the highest level has x number of criteria, and each of these high-level criteria is further divided into several sub-criteria. A survey questionnaire is also designed for collecting pairwise comparison data. The questionnaire will include all the pairwise comparisons within criteria at a high level as well as sub-criteria level. The survey will target construction stakeholders, professionals, and academic individuals and the survey will be conducted for couple of months to certify the collection of a representative sample size.

Description of work performed up to this period – In-Progress.

Task 3 – Data Analysis

Proposed task description:

The objective of the third task is to conduct an analytical hierarchy process, which is a multicriteria decision-making method combining a hierarchy of decision criteria and consisting of both tangible and intangible factors for obtaining the priorities related to alternatives. In this analysis, first a decision hierarchy is developed in which the focus group/interview divides a complex decision problem into a number of hierarchical levels. Secondly, priority analysis is conducted in which a series of pairwise comparisons are made among the identified factors within each level. Lastly, consistency check is done in which the experience and knowledge of the interviewed key stakeholders are utilized to make a pairwise comparison with respect to overall decision goal. Here, a pairwise comparison refers to the comparison between pairs of homogenous elements. The results of AHP would be used to prepare a guide for practitioners to utilize ATC which eventually expedites contract delivery in ABC projects.
Furthermore, box plots will be created using R-studio to provide the descriptive statistics results of the survey. Once the data is analyzed, a binary logistic regression model will then be developed. The model helps predict the probability that an observation falls into one of two categories of a dichotomous dependent variable. Furthermore, the significance test, which validates the binary logistic regression analysis, uses the t-score to describe how the mean of the data sample with a certain number of observations is expected to behave. Whereas the P-value indicates the confidence level, in terms of correlation, of each variable with the dependent variable. For this analysis, a 90% confidence interval will be assumed.

Description of work performed up to this period – In-Progress.

Task 4 – Recommendations and Metrics

Proposed task description:

This task compiles and comprehends the data analyses by providing a robust approach using the analytic hierarchy process and binary logistic regression analysis. This approach will facilitate the construction stakeholders to determine the applicability of ATC in ABC projects by taking into account a wide range of criteria. In this research, criteria hierarchy associated with ABC will be developed through focus group/interviews. Then, the identified criteria consist of a subset of decision criteria that are relevant to the research objective of ABC projects. Due to the involvement of different construction, transportation, and structural experts with various backgrounds in this study, the decision criteria will be defined in such a way that the comparison of conventional contract delivery methods with ATC can be satisfied by many different experts. The process is highly influenced by the input data obtained from the focus group discussions, yet the validation (distribution of surveys) will be introduces to guarantee the normality of results. The analytic hierarchy process is efficient when used for problems with relatively small number of alternatives.

Description of work performed up to this period – In-Progress.

Task 5 – Final Report

Proposed task description:

A final report will be developed to summarize the research conducted by FIU and recommendations developed from the research; this deliverable also includes a Guide, 5- min video presentation and sharing of Project Data.

Description of work performed up to this period – In-Progress.

5 Expected Results and Specific Deliverables

One of the primary outputs for the project will be the "Guide to Use of Alternative Technical Concepts (ATC) for Contract Delivery Methods in Accelerated Bridge Construction (ABC)". This guide will summarize existing challenges, discuss incentive/disincentive Clauses on ABC, and showcase best practices of ABC projects that included ATC in the bid procedure and project delivery. Anticipated output would be a metric to successful ABC projects for owners to consider.

5.1 Applicability of Results to Practice

Adding a more rigorous metric that can forecast ABC projects for owners precisely when ATC are enforced, will position this research project to complement previous endeavors where the cost and contractual methods were analyzed for ABC projects. To this end, ATC in ABC projects can be universally utilized.

6 Schedule

Progress of tasks in this project is shown in the table below.

Progress of Tasks

Task #	Research Task	2020								2021							
		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
1	Literature Review																
2	Data Collection																
3	Data Analysis																
4	Recommendations and Metrics																
5	Final Report | "Guide to Use of ATC in ABC"																

Work Performed
Work to be Performed

Item	% Completed
Percentage of Completion of this project to Date	5%

7 References

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