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SUSTAINABLE DEVELOPMENT GOALS INTEGRATED INTO THE A+B BIDDING METHODS FOR THE ROADWAY PROJECTS

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Abstract

The highway construction industry has a favorable impact on traffic services when road operations and maintenance effectively provide convenience for users and society in terms of environmental life cycle sustainability. The project procurement process that leads to contract launch is an important part of the construction industry. Alternative contracting methods (ACMs) such as A+B bidding are relatively popular in reducing the duration of road projects, with the main purpose of reducing road user costs. To realize the Sustainable Development Goals (SDGs) launched by the United Nations (UN), the addition of SDG components should be recommended as an integrated part of determining the winning tender for roadway construction projects. This paper is the first to offer a theoretical concept to incorporate the relevant SDGs into ACM to regulate the contractor winning the tender for highway construction projects.

Keywords: Sustainable Development Goals; Alternative contracting methods; A+B bidding method; roadway project procurement.

Introduction

In recent years, following up on the 2015 UN SDGs that intend to improve and secure the sustainability of the earth's life cycle, all countries in the world (including the elements within them) have taken an active role in realizing these goals. The focus of these sustainable development goals is directed at three significant dimensions of development: environmental, economic, and social.

Construction project activities, especially transportation infrastructure, are significant in affecting the survival of ecosystems and have the potential to destroy biodiversity (Myklebust & Myklebust, 2018). Therefore, this should be a consideration in the early part of the project cycle (Opoku, 2019). This implies that the delivery process of transportation projects must actively contribute to environmental sustainability, which is also closely related to social and economic life.

Alternative contracting methods (ACMs) have been successful in reducing the number of days (Chen et al., 2016; Hale et al., 2009; Herbsman, 1995; Molenaar & Songer, 1998) in road construction projects such as lane widening, resurfacing, rehabilitation, and reconstruction, as well as bridge repair and replacement projects on operating roads. One type of ACMs is the A+B bidding method, which is a bid for (1) the construction cost, and (2) the time to complete the project. Both (cost and time) of the project are proposed by the bidder. From that combination, the lowest cost will be awarded the winning bid, while the contract cost is only the construction cost. The reason behind introducing this bidding method is that besides of higher vehicle operating costs, road users will lose excessive opportunities for activities (known as the social cost of road users) due to the prolonged duration of the project will burden road users to detour and queue for a longer time.

With the reduced project duration from the practice of the contracting method, it is logically understood that social user costs, including environmental costs and economic costs, can be reduced. Social and economic costs can be clearly calculated with the reduced project duration as implicit in the calculation of work zone road user cost per day (DRUC) (Mallela & Sadasivam, 2011) which has been used in determining portion B of the A+B method. The integration of green contractor environmental cost components into A+B bidding method has already been proposed (Ahn et al., 2013) but is only limited to environmental costs. This paper intends to comprehensively improve the determination of winning bids using the A+B method, by integrating the global targets of the SDGs into the method as part of the effort to realize the achievement of the SDGs.

Determination of SDGs' Goals, Targets, and Indicators Proposed to be Included in the A+B Method

The SDGs consist of 17 goals and are supported by 169 targets and 232 global indicators to achieve them (UN DESA, 2023). The SDGs should be seen from a universal and interconnected perspective among its goals, not separately (Nilsson et al., 2016). Therefore, the determination of goals integrated into this bidding method will be based on a holistic view of the SDGs.

Not all SDGs goals and targets will be adopted here. This study considers four categories/clusters according to the sustainability dimensions (economic, environmental, and social) plus the non-domain dimension. After studying the categorization of goals in sustainability dimensions proposed by several pieces of literature, we adopted the formulation proposed by Rockström & Sukhdev (2016) because the interrelationship between goals is more acceptable as a holistic view that is mutually reinforcing among the three pillars of sustainability.

Since the A+B bidding is primarily applied to projects where the road is already in operation, the targeting of SDGs integration takes into account the relevance of the targets to the interests and impacts most likely to be caused by the road construction works. Here, 9 goals (SDG 3, SDG 4, SDG 6, SDG 8, SDG 9, SDG 11, SDG 12, SDG 15, and SDG 17) were selected for inclusion as assessment indicators in this bidding process with 25 achievement targets (Table 1).

Table 1: 25 SDG targets considered in ACMs integration

Dimensions of sustainability:	Economic	Environmental	Social	Non-domain
Target number in SDGs:	8.4, 8.8, 9.1, 9.4	11.2, 11.4, 11.5, 11.6, 12.2, 12.5, 12.6, 12.7, 15.1, 15.2, 15.3, 15.4	3.4, 3.6, 3.9, 4.3, 4.4, 6.3, 6.4, 6.6	17.7
Total targets:	4	12	8	1

The indicators set by the UN for each target (UN DESA, 2023) serve as a reference for measuring general performance achievements. However, in this study, it is proposed that the indicators used in the technical bid evaluation process will be determined by the owner/ State Highway Agency (SHA) by specifying a sustainability action plan that must be fulfilled by the contractor (will be studied separately).

Integration of Formula A+B+SDG

The successful application of the A+B method has illustrated how reduced project duration is achieved by integrating a user cost component in the formula. This study uses a similar principle by adding an SDG cost component, with the purpose of reducing the impact on the sustainability pillars of development. The formula constructed here is a concept that can be further refined in the future, especially on the SDG component. The addition of the SDG component to this method will use the 25 targets as in Table 1, written as the 'SDG' part in the formula for determining the winning bid as in Equation (1) below.

$$Total\ bid = \mathrm{A} + \mathrm{B} + \mathrm{SDG} \qquad \text{(Equation 1)}$$

where, A = construction cost ($); B = time cost = DRUC * days ($); SDG = SDG cost ($). DRUC is calculated by the owner/SHA based on the specified parameters that correspond to the object of the work site, while the number of project days (days) is proposed by the bidder. SDG cost is calculated by multiplying the SDG weight and construction cost.

Roughly speaking, the SDG cost is a measure decided by the magnitude of the impact caused by the work, in this study set at 100%. If the bidder has a proposed sustainability action plan for the work, it will be evaluated against the achievement of 25 predefined targets. Say, a bidder, proposes an action plan that addresses all 25 targets, then there is no negative impact. Conversely, if none of the targets are met at all, the bidder makes 100% impact. This impact is shown as the cost of economic, environmental, and social degradation due to the construction project. This means that the smaller the SDG costs, the smaller the negative economic, environmental, and social impacts.

For this study, the concept of calculating the weight of each target is approximated by assuming the weight of each target is the same. It is determined in Equation (2).

$$W = \frac{100\%}{25\ targets} = \frac{1}{25} = 0.04\ per\ target \qquad \text{(Equation 2)}$$

The quantification of these weights can be studied in more depth in the future by calculating weight of the various indicators of the sustainability action plan to be determined. Next, the determination of SDG costs is proposed in Equation (3).

$$SDG\ costs = \{(1 - (W \times N)) \times A\} \qquad \text{(Equation 3)}$$

where, N is the number of targets met by bidders (maximum N = 25). Whereas A is the construction cost bid by the bidder. This explains that, if the bidder meets all the specified targets, then the construction phase won't have a negative impact characterized by a low total bid.

Based on Equations. (1) - (3), Equation (4) is formed.

$$Total\ bid = \mathrm{A} + \{DRUC \times days\} + \{(1 - (W \times N)) \times A\} \qquad \text{(Equation 4)}$$

Case Study and Discussion

We tried to perform simulation calculations to illustrate the results achieved by applying this concept.

Most states, including Minnesota, in the US have implemented the A+B bidding method since the early 1990s. Therefore, by looking at the availability of data, the simulation in this study was carried out as an example to confirm the proposed equation model using bid tabulation data from the Minnesota Department of Transportation in 2021. The project contract description is Grading, Concrete and Bituminous Surfacing, ADA Improvements, Signal Systems and Lighting on "Sherburne County on TH 10 from Simonet Dr. to Lowell Ave." (MnDOT, 2021). Of the 8 vendors submitted bids, we retrieved the data of 5 vendors for this simulation (Table 2).

Table 2: Bid Tabulation Using A+B+SDG Bidding Method

Bidder	A cost ($)	A (rank)	B, days	Time value ($)	A+B ($)	N	SDG cost ($)	Total Bid ($)	Total Bid (rank)
A	9,564,090	1	196	2,940,000	12,504,090	20	2,500,817.97	15,004,907.80	2
B	9,731,470	2	186	2,790,000	12,521,470	18	3,506,011.63	16,027,481.74	3
C	9,848,767	4	191	2,865,000	12,713,767	15	5,085,506.60	17,799,273.10	5
D	9,833,479	3	196	2,940,000	12,773,479	23	1,021,878.32	13,795,357.32	1
E	10,078,672	5	186	2,790,000	12,868,672	17	4,117,975.04	16,986,647.04	4

The more targets met in the bid, the greater the chance of getting the bid award. As can be seen, Bidder A has the lowest construction cost and the highest number of days which is the same as Bidder D which has a difference of 2 targets more than Bidder A. Finally, Bidder D is the winner of the bid due to the large difference in Total Bid.

The proposed equation model shows the importance of the lowest combination of contractor bids (construction cost, number of project days, and fulfillment of SDG targets) to get a chance of winning the bid. However, the significance of the findings of this integration model is that apart from following up on reducing the social costs of road users, it is also to reduce the economic, environmental and social impacts due to roadway construction activities.

Conclusion

This study is the first to propose a scheme for integrating the economic, environmental, and social elements of sustainable development into the initial framework of the construction phase for road projects through the A+B bidding method. With this integration, the involvement of contractors in the road construction sector in reducing economic, environmental, and social impacts will be directly visible. The A+B+SDG method indirectly puts pressure on contractors to think about and strive for innovations that help realize sustainable development goals. Future work on the formatting of SDG components with detailed weight computations for each target and the determination of sustainability action plans will be an interesting topic.

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