

## IDENTIFICATION OF MAIN OBSTACLES TOWARD GREEN OPERATIONS ON HIGHWAY CONSTRUCTION PROJECTS IN CAMBODIA

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### *Abstract*

Highway construction projects are growing rapidly to reform infrastructure systems in developing countries, resulting in a higher level of pollutions generated from heavy equipment usage and construction operations throughout the project life cycle. An increase in the environmentally friendly momentum then drives the construction industry to start adopting green technology to reduce emissions over the community. Nevertheless, the obstacles on green technology implementation in highway construction still blocked many contractors to pursue sustainability and contribute their helps to the environment in developing countries such as Cambodia. This paper aims to determine the main barriers that prevent contractors to pursue sustainability in the Cambodian highway construction area. 27 lists of factors were determined under six dimensions of censorious obstacles: (1) funding issue; (2) cooperation and attitude; (3) green material resource; (4) government management; (5) time and schedule; as well as (6) training and knowledge. All the obstacles were preliminarily identified from a comprehensive literature review. The questionnaire was next developed and applied for an interview with professional contractors who have experience in highway construction projects in Cambodia. The results from the total respondents were collected and analyzed in terms of the descriptive statistic to rank the highest critical obstacles among six dimensions. The finding of this paper helps government agencies to identify the main obstacles on green implementation and suggest competent solutions for the contractors in Cambodian society towards sustainability.

**Keywords:** Sustainability; Contractor obstacles; Green Implementation; Highway construction; Cambodia

### 1. INTRODUCTION

The crucial augment in climate and global warming has been discussed in the whole industrial sector [1]. Air pollution is the terrorizing material in the atmosphere that produces a negative result on human health and the community. Among all industrial sectors, construction is a remarkable cause in generating different kinds of pollutants. For different types of projects, activities from highway construction were considered as one of the vital issues on emissions [2] as it consumes a sizeable number of materials and energy as well as produces an extensive amount of waste [3]. Pavement construction projects' actions are possibly released 20% of overall global warming, leading the project planner to consider sustainability with comprehensive aspect [4]. Some types of materials used in the highway industry, such as aggregate and hot-mixed asphalt are considered as an

element of the CO<sub>2</sub>, CH<sub>4</sub>, and N<sub>2</sub>O catastrophe which is inimical to the instigation of low carbon emission [5]. To improve this big issue, sustainable construction industry is very important to stabilize people's needs such as safety, healthy and physiologically pleasant community [6]. The specification of green technologies and the connection of green components assist sustainability goals and provide sustainable development [7]. Nevertheless, adopting green concept is not straightforward, and it faces many barriers on construction parties especially contractors.

Many researchers have attempted to investigate and summarize the lists of obstacles for green technology adoption. However, they mainly focused on the developed regions such as Europe and North America, and it is still lacking research works on developing countries, especially Southeast Asia like Cambodia. Cambodia is a country located in Southeast Asia and also be a member of the Association of Southeast Asian Nations (ASEAN) [8].

Recently, the construction industrial sector in Cambodia grow significantly follows the GDP of the country [9]. Nevertheless, sustainability in the highway construction industry in Cambodia has gained little attention from practitioners. The purpose of this research is to identify the obstacles that prevent contractors to pursue sustainability in the Cambodian highway construction field. As a result, project planners and contractors can realize the serious effect of emissions and determine an effective way in reducing pollutants in the allowance standard to save society. The finding of this paper assists government agencies in determining the critical barriers in adopting the green concept and further provides insight on potential solutions for highway contractors in Cambodia.

## 2. LITERATURE REVIEW ON CONTRACTOR OBSTACLES ON GREEN TECHNOLOGY ADOPTION

Recently, the importance of sustainability has been recognized as the prime goal in the construction industry. In developing countries, there are many different challenges in reducing emissions. Many past studies summarized the obstacles on green technology adoption. Based on the past literature, the obstacles can be grouped under six dimensions: (1) funding issue, (2) cooperation and attitude, (3) green material resource, (4) government management, (5) time and schedule, and (6) training and knowledge. These six categories inclusively cover the mostly mentioned obstacles on green adoption [10]–[11]–[12]–[13].

### 2.1. FUNDING ISSUE

Financial problem consistently happens in the construction industry [14]. Adopting green technology tend to increase project cost in several aspects. It impacts the primary cost significantly [15]–[10], as green materials seem more expensive than traditional ones [16]–[17]. Moreover, some types of green materials have to deliver abroad [18]. Another barrier on green technology adoption is that some construction projects require the qualifying contractors effectively with the higher certification and design involvement in the project [19]. The complex green technology needs qualified contractors and to deal with its major problems. Some projects that adopt green

technology result the project delay due to the complication of green technology use causing serious financial problems with more extra funds spent on the project [12]–[20].

### 2.2. COOPERATION AND ATTITUDE

Starting to bring forward the new green technology implementation necessarily needs cooperation from related parties involved in the project, especially the project owner. Green technology adoption mostly fails due to a lack of project owner's demand or interest [21]–[22]. Emission reduction commitment should usually be discussed at the early project stage; however, contractors exclusively join in the construction phase without any opportunity to join the discussion for pre-project planning [16]. Moreover, some labors and subcontractors are unwilling to employ green technology. Lacking cooperation between contractors and subcontractors can increase more difficulty in adopting the new green technology [23]–[11]. Also, it would be more complicated when contractors feel hesitated with the quality and performance of green technology [22].

### 2.3. GREEN MATERIAL RESOURCE

Green material is very crucial in every highway project. Some contractors found difficulty in sourcing green material, unknowing clearly about the actual performance of the project [10]–[16]. Most contractors had experience with traditional methods and it is quite hard to perform the operation of green technology. Also, it can be hard when the green technology material, information, and databased is insufficient in the country [16]–[23]. In developing countries, research development centers and facilities on green technology are scarce [23] and cannot access valid tests of green technology to clarify the green performance [22]–[13].

### 2.4. GOVERNMENT MANAGEMENT

Without support from the government, green technology adoption will be not smooth. To achieve green technology adoption fluently, it shall be supported by the top government in the country [14], in which some of them do not pay attention on [12]–[21]. This leads to

the lack of promotion or exhibition supported on technology use [16]–[24]. People in the country have perceived little information about sustainability. The government should also establish green technology codes and regulations to set up the standards for construction in the country [20]–[25]. Moreover, the government could directly support funds to companies for their green technology adoption [20], or even reward contractors or construction companies with the recognition or certificate to appreciate the performance in reducing emissions [22]–[26]. Another obstacle is the high tax on green material [18]. As such, the government should facilitate the green material to have a lower tax than other traditional products.

### **2.5. TIME AND SCHEDULE**

Time constraint is always a challenge in the construction industry. Construction companies differently receive punishment when they cannot timely complete the project. Thus, a tight project schedule does not allow contractors to use new innovative green technology, forcing the project to have relied on existing methods. Besides that, a narrow project schedule leads the contractors not to think about emission reduction but only focusing on the project duration [16]–[27]. Green technology adoption can cause project delays every time [10]–[12]. Some green materials need to be ordered from abroad due to their unavailability. The long period of delivering those green materials from other countries can make construction to be postponed [18]. Then, the traditional method seems to be more preferred when the adoption of green technology is quite complex.

### **2.6. TRAINING AND KNOWLEDGE**

Using new green technology is tough, since contractors need advanced knowledge and skills [16]. Lack of certification systems or training is very challenging for contractors [16]–[27]. Large and complex construction projects typically need qualified contractors; as most of them never experience on using green technology before. This could create more problems due to inexperience and unfamiliarity with green technology design, materials, and products [25]. Some contractors and subcontractors worry

about some dangers and risks that can occur during the use of green technology due to lacking the expertise and experiences [16]–[23].

In this study, all obstacles from past literature were addressed by the most frequently happen. If an obstacle appears least among all papers, it will not be taken to the final list in the questionnaire. Moreover, some irrelevant obstacles that are not related to highway construction were cut out. Finally, 27 obstacles under six categories have been formed, as the list shown later in the result and discussion section.

## **3. RESEARCH METHODOLOGY**

### **3.1. QUESTIONNAIRE DESIGN**

The questionnaire was established to gather the compulsory data. The obstacles of green technology adoption in the highway construction industry were firstly studied to determine the theory and the details of critical obstacles. The rating-scale technique was applied to present the level of impact on each obstacle. The developed questionnaire was reviewed under the pre-test interview with 10 construction engineers to check the capabilities of the questionnaire survey before actual data collection. The respondents also provided more lists of obstacles and comments from their work experiences to improve the questionnaire. The questionnaire then got revised accordingly before proceeding with an actual data collection and interview.

### **3.2. DATA COLLECTION**

The survey was distributed to public contractors on the construction highway projects in Cambodia. Table 1 shows the profiles of all respondents participating in the data collection. The questionnaire will be sent to the respondents by email and other social media such as Facebook application or Line. Besides, a google form was created to facilitate respondents. The first part of the questionnaire will acquire the respondent's profile. Afterward, the respondents were questioned to rate the level of impact on the list of obstacles with five-point Likert scale (0= no impact, 1 = very slightly impact, 2 = slightly impact, 3 = quite impact, 4 = strongly impact, and 5 = extremely impact). The result of the survey aims to

provide the level of impact from each obstacle on sustainability implementation for road construction in Cambodia.

Table 1 Respondents' Profiles in Data Collection

Respondents Profiles	Number of Respondents
Position	
- Project Engineer	5
- Site Engineer	2
- Subcontractors	4
Experience	
- More than 3 years	7
- More than 5 years	3
- More than 7 years	1

It is worth mentioning that only 11 respondents were preliminarily collected their information and perspectives in this paper due to the time limitation. More respondents are planned to be gathered in the future. Nevertheless, at this stage, the reliability of data can be verified related to the respondents' qualifications. All 11 respondents are professional engineers who have #enough skills and knowledge in the highway construction field more than 3-year experience. They can provide reliable and relevant answers, as they have well understood the norm and context clearly on highway projects in Cambodia.

### 3.3. DATA ANALYSIS

Data collected from the survey were quantitatively analyzed by calculating the mean value of each obstacle. The standard deviation was also determined to help to identify the importance of obstacles that have the same mean value. Smaller standard deviation stands higher rank than the others. Afterward, all obstacles were ranked and six categories of critical obstacles were compared.

## 4. RESULT AND DISCUSSION

The perspectives toward green technology adoption from all respondents on 27 lists of obstacles were shown in Table 2. Most contractors believe that time is very potential for construction projects. The average time and schedule category stands the highest rank among all six categories with an average value of 3.52. The result indicates that contractors are deeply concern to project schedule. Some contractors state that their projects

spend more money due to project delay, providing a similar conclusion as shown in [28]. Among the three obstacles in this category, a long period of delivering green material appears to be the highest mean value (3.64). Most contractors believe that green material is difficult to find, and need to order from other countries, so the duration of delivering green material causes the project delay, which has mostly frustrated contractors. Likewise, the problem of green suppliers is very affected by the project schedule [12] due to not trusting the performance of quality of green material, resulting in an international purchase and delivery. Another obstacle is adopting new green technology causing project delay. It is the second-highest mean value in this category (3.55). The result proved that most contractors worry about new green implement that can prolong the project. The short schedule of the project appears in the third rank in this category. One site engineer in the survey stated that the traditional method is preferred rather than green technology if the projects schedule is short or rush. Three obstacles in time and schedule category seem impact and important to green implement adoption.

The second-ranking of the six categories is government management with an average value of 3.47. Most obstacles in this category show that government should pay attention and contribute more help to the construction industry in Cambodia to retain sustainability. The highest rank of obstacle in this category was lacking green reward, certificate, or recognition programs to appreciate contractors. Most governments need to play an important role and provide an award to contractors who have willing on green implementation. The six obstacles in this category have a mean value from 3.00 to 4.09. All obstacles, including no financial support, green material taxation, and a lack of significant intention from the top government are very crucial. The finding from this study also showed the similarity with the result from [10].

Next, the third ranking of six categories is the funding issue with an average value of 3.38. Most contractors state that financial problem is very important. One contractor indicates that the financial support on green implementation is very important in helping the project

Table 2 Analysis Result on List of Obstacles

No.	List of Obstacles	Mean Value	SD	Rank
	1. Funding Issue	3.38		
1.1	Increase of primary project cost due to use of green technology.	3.64	0.99	4
1.2	High costs of green materials and technology.	3.45	0.51	8
1.3	Project cost increase due to higher certification and design requirements.	3.36	0.93	10
1.4	Capacity to deliver green material for acceptable cost constraints.	3.18	0.70	15
1.5	Financial problem from project delay caused by using green practices.	3.27	0.84	14
	2. Cooperation and Attitude	2.93		
2.1	Lack of interest in green environment from parties involved in projects.	3.09	0.81	21
2.2	Doubt on quality and performance of applying green technology	2.73	0.75	27
2.3	Lack of cooperation between contractors and subcontractors in green technology use.	3.09	0.50	17
2.4	Incomplete international agreements for emission reduction.	3.00	0.89	24
2.5	Lack of project owner's demand or interest toward green adoption.	2.73	0.72	26
	3. Green Material Resource	3.07		
3.1	Difficult to know green materials without knowing actual performance.	3.18	0.94	16
3.2	No access and valid test of green technology and materials in country.	2.91	0.64	25
3.3	Insufficiency of information and database on green material and green technology.	3.09	0.67	20
3.4	Lack of research development center and facility on green technology.	3.09	0.61	19
	4. Government Management	3.47		
4.1	No attention from top government on green technology in country.	3.45	0.50	7
4.2	High tax on green material in country.	3.09	0.81	21
4.3	No financial support from government.	3.00	0.71	23
4.4	Lack of green technology codes, regulations and evaluation standards.	3.73	0.57	2
4.5	Lack of promotion or exhibition supported by government on green technology use.	3.45	0.51	8
4.6	No green reward, certificate, or recognition programs to appreciate contractors.	4.09	0.61	1
	5. Time and Schedule	3.52		
5.1	Not allow adopting new green technology due to of short time schedule.	3.36	0.93	10
5.2	Adopt new green technology causes project delay.	3.55	0.91	6
5.3	Long period of delivering green material from other countries.	3.64	0.46	3
	6. Training and Knowledge	3.30		
6.1	Lack of green certification systems or training.	3.55	0.49	5
6.2	Insufficient designing and technical expertise.	3.09	0.58	18
6.3	High technological risks and dangers while using new green methods.	3.27	0.71	13
6.4	Limited experience in using green technology methods.	3.27	0.55	12

to be more successful. One obstacle in this category that emerges with the highest mean value (3.64) is increasing the primary project cost due to the use of green technology. The results of the other four obstacles in this category show that most of the obstacles related to

funding issue seem quite impact to contractors. The results from past literature also show similarity that an increase of primary cost is concerned for the contractors [12]–[23].

After funding issue, training and knowledge category stands in the fourth ranking among six critical categories with an average value of 3.30. Without knowledge of green technology adoption, it is hard for contractors to operate all kinds of work on site. Some of the respondents provide their opinion about sustainability toward learning the knowledge on emission reduction and green technology. The highest-ranking in this category with a mean value of 3.55 can prove that contractors believe the certificate clarification is very important in the workplace especially in Cambodia. The other three obstacles in this category such as insufficient expertise, limited experience, and risk and danger also quite impact to contractors that need to figure out solution to deal with obstacles in this category.

Fifth-ranking of six categories is the resource green material. This category also impacts contractors, but the mean values obstacle under this category are lower than the other four categories above. Most respondents rated one obstacle that shows the difficulty to source green materials without knowing the actual performance. Contractors are concerned about the way how to calculate the amount of green material in the projects. Another obstacle that rates the second highest mean value in this category is lacking research development centers and facilities on green technology. It shows that the scarcity of research center on green implementation that would be difficult for contractors to get green materials or trust green material that uses in the project. Moreover, lacking a database and information quite affect contractors by showing a mean value of 3.09.

The last ranking number among six categories of obstacles is cooperation and attitude. The average value is 2.93. It shows that contractors also worry about the manner of all parties involved in the project. All obstacles in this category are less important than other obstacles but still quite impact contractors' perspective toward sustainability. In contrast, [12] showed that attitude toward green implementation is quite very impacted for contractors. It seems like respondents in Hong Kong that mention in [12] more focus on familiarity construction method that can make projects faster, cost-saving, time-saving and convenient, so contractors are less focused on

green implementation. In contrast, contractors in Cambodia believe that cooperation and attitude toward green implementation can go smoothly when all parties involved in the project signing the agreement and not wasting the revenue throughout project operation.

After all, obstacles have shown the level of impact on contractors' perspective. The scale of rating questions from 0-5 is very potential to consider the most impact obstacle among 27 total factors. In rating scale from no impact to extremely impact, most obstacles showed the level between 3.00 to 4.00, meaning from quite to strongly impact on green implementation.

A similar level of mean values seems to show that contractors' perspectives are relatively similar among all obstacles. When all obstacles happened in the actual work experience, most contractors probably think that they are quite impact and importance in the same or similar level of impact. Moreover, the relationship between each obstacle that appears in any stages of the construction projects may cause contractors to provide a close rank of the level of their impact. The level of quiet impact from 3.00 to 4.00 on most obstacles in the list can show that contractors were come up against all obstacles with the difficulty and complication in their projects. In contrast, some obstacles will pop up a higher level of perspective than the other obstacles if they significantly occur and create problems in the projects. Different locations and scales of projects would cause each obstacle to have a higher impact compared to normal projects. Many issues from large-scale projects will occur more than usual. Moreover, work experience or responsibility in workplace of contractors are also the factors resulting in some obstacles get high rank among the list.

## 5. CONCLUSION

Green technology is very potential to keep the community sustainable. Identifying the critical obstacles to green technology adoption can help the Cambodian construction industry to lower amount of emissions. Statistical analysis of data collected from highway contractors in Cambodia was conducted and the views of the 27 obstacles were examined that four categories of

critical obstacles were quite impacting on contractor's perspective toward green technology. Time and schedule, government management, funding issues, and training and knowledge were found to be the main critical obstacles, but other two categories such as green material resource and cooperation and attitude are also somehow potential. The aftermath from this paper provides the highest impact ranking of obstacles from contractors' perspective to determine the vital green implementation issue in highway construction. However, this work requires further data collection from project owners parties to reveal their perspective toward green implementation. Data collection from both sides such as project owners and contractors can figure out their different perspectives, so more practical and promising solutions can be suggested on government agencies and policymakers for the author's further work.

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