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Delays in Major Agricultural Infrastructure Projects in Guyana: Causes and Proposed Solutions

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Abstract: *Delays are a universal phenomenon in the construction industry, and there is no exception for major agricultural infrastructure projects undertaken in Guyana. The paper presents the results of a study conducted to identify and evaluate the relative importance of the main causes of delays, and discusses the methods of minimising delays in major agricultural infrastructure projects in Guyana. Respondents for this study included personnel from clients (owners), contractors and consultants involved in drainage and irrigation projects in Guyana. It was found that the main causes of delays in construction of major agricultural infrastructure projects included: weather conditions, poor access to site, too optimistic estimate of project duration, unforeseen site and/or ground condition, and necessary change orders/variations. Moreover, client-related delays were ranked as the main category that caused project delays. Hence, it is essential to have sufficient time and money been allocated at the design stage and a multi-disciplinary team been employed in order to minimise delays in major agricultural infrastructure projects in Guyana.*

Keywords: *Agriculture; Construction management; Delay Time; Drainage; Irrigation*

1. Introduction

Delays are a universal phenomenon in construction (Ahmed et al. 2003). Assaf and Al-Hejji (2006) defined a delay as "the time over-run either beyond the completion date specified in a contract or beyond the date that the parties agreed upon for delivery of a project". Hence, an agricultural infrastructure project delay is simply the completion of the project beyond the date originally set for completion. There was a problem of time overrun in major agricultural infrastructure projects in Guyana. The agricultural infrastructure projects referred to are defined as the construction and/or rehabilitation of drainage and irrigation (D&I) structures, and the associated bridges and access roads included in the work.

According to Saeed and Honggang (1998) a number of governments used investments in infrastructure in the past as an important means of achieving agricultural development. Carruthers and Seckler (1997) stated that low product prices in 1980's created poor rates of return for irrigation investment which slowed the irrigation boom. Moreover, Carruthers and Seckler (1997) noted that global food prices which remained low in that period were a consequence of the massive green revolution wheat and rice production gains. The low product prices were due to a surplus of stocks of grains in northern countries through the introduction of high yielding varieties.

Headley and Fan (2010) made a similar observation and stated that as a result of the decline of the real prices of staple foods for most of the last 30 years, a consequence of the green revolution, investments in the agricultural sector was no longer considered a priority by governments until the 2008 World Food Crisis. This view was also shared by Ringler and Pnadya-Lorch (2011). It was noted that the 2008 food crisis alerted governments to the importance of agriculture and prompted them to reinvest in the agricultural sector. Inocencio et al. (2005) referred to this as the "irrigation response" to the food crises. A similar response was also observed in Guyana.

Guyana is an English speaking country situated on the northern coast of South America. The country is divided into 10 Administrative Regions (see Figure 1), and has an economy that is based largely on agriculture and extractive industries which account for 24.2 % of its GDP (CIA 2012). Farming is permitted by an extensive network of drainage and irrigation canals in Regions 2, 3, 4, 5, and 6, with the primary emphasis on drainage because the coast is below mean high tide. The two primary crops cultivated are rice and sugar cane. The scope of this paper was limited to delays in major surface D&I projects within private farming communities in Regions 2, 3, 4, 5, and 6 of Guyana which was completed within the period January 1, 2006 to December 31, 2011 and had a value of more than US$ 450,000 each.

Figure 1. Map showing the Administrative Regions of Guyana

In Guyana, groundwater irrigation projects were not a common practice, and as such, these projects were not developed on a large scale. In addition, D&I projects with a contract sum of less than US$ 450,000 were supervised directly by the owners. These projects were not considered for analysis since a reliable conclusion cannot be determined from the Consultants' responses.

The geographical extent of this study was restricted to regions in Guyana where rice and sugar cane were extensively cultivated since any delays in these projects would have a pronounce impact on Guyana's economy. Moreover, the analysis period was selected because there was a notable increase in the execution of projects of this nature. The scope of the research was used to filter the questionnaires collected to determine successful respondents.

Delays in the execution of major agricultural infrastructure projects had a negative impact on Guyana's economy. These projects were usually executed in communities while farming activities were being carried out simultaneously, and resulted in reduced yields or crop loss. This reduced the produce available for the export market, and ultimately restricted the foreign exchange earned by the country. As a consequence, there have been a number of unique causes of delays during the projects which resulted in notable time overruns. The paper presents the findings from the study that investigated into the main causes of delays in major agricultural infrastructure projects, and proposes methods of minimising these delays in Guyana.

2. Literature Review

Table 1 depicts the findings from a review of relevant literature concerning the delays in irrigation and related projects. Despite the fact that some studies were done directly into the causes of time overruns in major surface irrigation projects by Inocencio et al. (2005), Jones (1995), and Suphaphiphat (1995), these researchers failed to obtain the viewpoints of the consultants, owners, or contractors for the delays they identified in

Table 1. Reviews of Delays in Irrigation and Related Projects

Author(s)	Study Description	Methodology	Results
Jones (1995)	208 irrigation projects funded by the World Bank from the period 1950 - 1993 that were previously evaluated	Review of post-evaluation bank reports along with 2 questionnaires surveys to confirm findings	The study noted that the most common reasons of delays were shortage of borrowers' funding, procurement problems, problems with design preparation and changes, construction materials' shortages, institutional problems, problems with contractors, and land acquisition problems. 129 problems in irrigation projects were grouped them into 16 categories.
Suphaphiphat (1995)	Three major irrigation projects completed in Thailand that were approved by the Asian Development Bank within the period 1968-1985.	Review of post-evaluation bank reports	The study identified 6 factors that caused time overruns, and noted that slow delivery of construction equipment was the main factor that caused time overruns.
Inocencio et al. (2005)	314 irrigation projects implemented from 1967 to 2003 in 50 countries, in six regions financed (or aided) by the African Development Bank, World Bank, and the International Monetary Fund for Agriculture Development	Review of post-evaluation bank reports	The study identified 14 factors causing time overruns, stating that insufficient finance during project implementation was the main factor that caused time overruns.
Frimpong and Oluwoye (2003)	A survey into the causes of delays and cost overruns in groundwater construction projects in Ghana.	Questionnaire survey from the perspective of owners, consultants and contractors.	The study identified 49 factors that caused delays and cost overruns and grouped them into 9 categories. A monthly payment difficulty was the main factor that caused delays and cost overruns, and project financing was the major factor category that caused delays and cost overruns.
Le-Hoai and Lee (2008)	A survey into the causes of delays and cost overruns that occurred during the construction phase of large construction projects in Vietnam	Questionnaire survey from the perspective of owners, consultants and contractors.	The study identified 21 factors that caused delays and cost overruns and grouped them into 7 categories. Poor site management and supervision was the main factor that caused delays and cost overruns, and owner-related was the major factor category that caused delays and cost overruns.
Yakub (2009)	A survey into the causes of delays in road construction projects in Guyana.	Questionnaire survey from the perspective of owners, consultants and contractors.	The study identified 75 major factors that contributed to the causes of delays and grouped them into 10 categories. The results ranked the weather conditions as the major factor that contributed to the causes of delays and the material related as the major category that contributed to the causes of delays.

these projects and correlate their findings. There was thus a knowledge gap with respect to the correlation of the viewpoints of the consultants, owners, and contractors for the causes of time delays in these projects.

3. Study Methodology

A structured questionnaire survey was employed. The findings information deduced from literature review was used, and the instrument developed by Yakub (2009) was adapted. The questionnaire was considered appropriate for this study because most of the delays listed is applicable to major agricultural infrastructure projects in Guyana, and it has been validated. A pilot survey via e-mail was then conducted to pre-test the questionnaire with representatives from the targeted groups of consultant and the client/government.

Based on the results of the pilot survey, several adjustments were made to Yakub's questionnaire. These are:

1) Three (3) causes of delays were modified: 1) Inadequate Client Experience, 2) Change Orders/Variations, and 3) Design Change.
2) Nine (9) causes of delays were added: 1) Lead Time of Imported Materials, 2) Inappropriate mode of transport to access site, 3) Inexperienced staff in the Client's Organisation, 4) Necessary Change Orders/Variations, 5) Scope Change by Client, 6) Time elapsed between approval of design and advertising of tender for the construction works, 7) Inexperienced Water Users Association members, 8) Lack of engineering workshops for farmers, and 9) Inadequate/Lack of Irrigation Schedule.
3) One category of delay was added (i.e., Water Users related).

The final version of the questionnaire consisted of 84 factors that caused delays in major agricultural infrastructure projects in Guyana (Yakub 2009). These factors were identified and compiled from literature review (e.g., Jones (1995); Suphaphiphat (1995); Frimpong and Oluwoye (2003); Inocencio et al. (2005), Yakub (2009)). The questionnaire was self-administered, and a 5-point Likert's scale was used according to the level of contribution (i.e., 1 = Very low, 2 = Low, 3 = Medium, 4 = High, and 5 = Very high).

For the purpose of this study, a Simple Random Sampling without replacement was used to select respondents from the population to partake in the full-scale survey. A sample size of targeted respondents was determined based on a summation of the data collected from senior personnel of the organisations identified by the Ministry of Agriculture in Guyana. In total, 48 questionnaires were sent to the targeted respondents (including 14 owners, 12 contractors and 22 consultants).

In order to determine the relative importance of the various factors that caused project delays, the score for each factor was calculated by summing up scores assigned to it by respondents. Therefore, the level of importance specified by respondents (such as contractors, owners, and consultants) was used to measure the relative importance of each factor. The Relative Importance Index was computed using the following formula:

$$I = \frac{\sum_{i=1}^{5} W_i X_i}{\sum_{i=1}^{5} X_i} \quad (1)$$

Where:

i = Response category index = 1, 2, 3, 4, and 5 (Questionnaire Response: Very high, High, Medium, Low and Very low, respectively);

W_i = The weight assigned to i^{th} response = 1, 2, 3, 4, 5, respectively.

X_i = Frequency of the i^{th} response.

For example, the Relative Important Index for the cause of delay 'Inflation / Price Fluctuation' from the Owners perspective is:

$$I = \frac{(1\times 3)+(2\times 3)+(3\times 3)+(4\times 1)+(5\times 2)}{(3+3+3+1+2)}$$

$$I = \frac{32}{12} = 2.67$$

The relative importance weights of the main factors were calculated based on the "average" of each delay factor, and then used to determine the relative importance index of the factors. These indices were used to rank the factors for each group. The ranking made it possible to cross-compare the relative importance of these factors made by the different groups. This would also determine the overall mean index and the rank for the factors identified. In addition, this data could be used to determine the rank agreement factor and percentage agreement.

4. Results and Discussion

The data acquired was analysed to determine the factors under the categories of delays, as identified from the literature review and pilot survey, and ranking them according to the significance of their influence in major agricultural infrastructure project delays. The ranking method could help determine the most significant factors within each category of causes.

4.1. Profile of Respondents

A total of 41 completed questionnaires (i.e., 85.4%) were received. Of these: 12 (25%) were from owners; 8 (16.7%) were from contractors; and 21 (43.7%) from

consultants. The profile of the respondents who successfully completed the questionnaire survey was examined to determine the experience levels of the participants. This revealed that 50% of the owners had no more than five (5) years experience in the construction industry. This may explain the ranking of the main categories of delays.

In addition, approximately 43% of the consultants and 38% of the contractors completed no more than two (2) major agricultural infrastructure projects within the scope of the study. This suggested that most of these respondents were recently exposed to projects of this nature. The profile of the respondents is presented in Table 2.

4.2. Description of Infrastructure Projects

A review of responses from the questionnaire survey revealed that drainage infrastructure work was part of the scope of work in the D&I projects. Besides, the respondents viewed the majority of the major agricultural infrastructure projects as new construction work. 73% of the respondents indicated that rice was the only crop cultivated during the construction work. However, only 56% indicated that the Water Users' Association (WUA) was involved in their projects. In order to prevent any delay in construction from affecting rice production, it is vital that the WUA be involved in all major agricultural infrastructure projects.

4.3. Main Categories of Delays

The category of client-related delays was ranked overall as the most important cause of delays amongst the 11 categories of delays identified. Although, Frimpong and Oluwoye (2003) identified project financing as the main category of delay in Groundwater projects in Ghana, it was noted that financing was ranked overall as the tenth most important cause of delays.

The difference in ranking indicated that the financing of major agricultural infrastructure projects in Guyana was not a major cause for delay. The findings showed that there was significant room for improvement in the management of these projects by the owners. The main categories of causes for major project delays are ranked in Table 3.

Table 2. Profile of Respondents

		Consultant (%)	Owner (%)	Contractor (%)
Experience in Construction Industry	0 - 5 years	9.52	50.0	12.50
	6 - 10 years	47.62	33.33	25.00
	11 - 15 years	4.76	8.33	37.50
	More than 15 years	38.10	8.33	25.00
Number of major agricultural infrastructure projects completed within the scope of the study	1 - 2	42.86	33.33	37.50
	3 - 4	28.57	41.67	25.00
	5 - 6	9.52	0.00	12.50
	More than 6	14.29	25.00	12.50

Table 3. Ranking of Main Categories on Project Delays

Categories	Contractor		Owner		Consultant		Overall	
	Mean Index	Rank	Mean Index	Rank	Mean Index	Rank	Mean Index	Rank
Client	2.86	2	2.99	2	2.83	1	2.89	1
Labour	1.9	8	3.05	1	2.74	5	2.56	2
External	2.89	1	2.27	7	2.48	6	2.55	3
Material	2.38	4	2.32	6	2.79	2	2.5	4
Management	2.34	5	2.83	3	1.94	10	2.37	5
Water Users	2.75	3	2.23	8	2.1	8	2.36	6
Contractor	1.53	11	2.73	4	2.79	3	2.35	7
Equipment	1.67	10	2.57	5	2.75	4	2.33	8
Consultant	2.17	7	2.2	9	1.71	11	2.03	9
Financial	1.71	9	1.97	10	2.17	7	1.95	10
Code	2.3	6	1.31	11	1.99	9	1.87	11

4.4 Causes of Delays

Of the 84 factors identified for this study, the rankings of the top 20 factors causing project delays are depicted in Table 4. Amongst the top 10 main causes of delays, four (4) were grouped under the external environment whereas three (3) were originated from the owners. Interestingly, the contractors were only responsible for one main cause amongst the top 10 main causes of delays. This indicated that 70% of the main causes of delays were attributable to the responsibility of owners, 10% were caused by the contractors, and 10% were shared between the owners and the contractors. The remaining 10% was caused by an 'act of God'.

It was found that the weather condition was the top main cause of delays in major agricultural infrastructure projects in Guyana. Yakub (2009) made a similar observation for road construction projects in Guyana. Generally speaking, the unpredictable weather pattern in

Table 4. Ranking of Top 20 Factors Affecting Project Delays

No.	FACTORS	Contractor	Owner	Consultant	Overall	
		Index	Index	Index	Mean	Rank
1	Weather Condition	4.83	3.67	4.14	4.21	1
2	Poor Access to Site	4.5	3.33	3.9	3.91	2
3	Too optimistic estimate of project duration	4.17	3.83	3.57	3.86	3
4	Unforeseen Site / Ground Condition	4	3.58	3.86	3.81	4
5	Necessary Change Orders / Variations	3.67	3.67	3.52	3.62	5
6	Poor Site Investigation before bidding	3	3.42	3.9	3.44	6
7	Slow decision making by Client	3.17	3.33	3.38	3.29	7
8	Shortage of Skilled Labour	3.33	2.92	3.24	3.16	8
9	Inflation/Price Fluctuation	4	2.67	2.71	3.13	9
10	Lack of / Inadequate Irrigation Schedule	4.2	2.5	2.61	3.10	10
11	Frequent Equipment Breakdown	2.5	3.25	3.43	3.06	11
12	Scope Change by Client	3	2.67	3.43	3.03	12
13	Escalation of Material Prices	3.5	2.67	2.81	2.99	13
14	Late Delivery of Materials	2.17	2.92	3.62	2.90	14
15	Low Labour Productivity	2.17	3.42	2.95	2.85	15
16	Lead Time of Imported Materials	3.17	2.5	2.86	2.84	16
17	Insufficient workforce	1.83	3.25	3	2.69	17
18	Slow decision making Process involving all Project Team	2.67	3.33	2.05	2.68	18
19	Time elapsed between approval of design and advertising of tender for the construction work	2.83	2.69	2.48	2.67	19
20	Slow mobilisation of Labour	1.5	3.42	2.95	2.62	20

Guyana had a major impact on the time overrun for external construction projects.

Poor access to site was the second main cause of delays in major agricultural infrastructure projects. In contrast, Yakub (2009) identified 'shortage of construction materials' as the second main cause of delay in road construction projects. However, in this study, 'shortage of construction materials' was identified as the 27th main cause of delay. Further, 'poor access to site' was not identified as a factor causing delay in the study by Yakub (2009). This indicated that 'poor access to site' was not a major cause of delay in road construction projects in Guyana.

'Too optimistic estimate of project duration' was ranked as the third main cause of delays in major agricultural infrastructure projects. In contrast, Yakub (2009) identified 'Poor Site Management and Supervision' as the third main cause of delay in road construction projects. However, in this study, 'Poor Site Management and Supervision' was identified as the 23rd main cause of delay. Moreover, 'Too optimistic estimate of project duration' was not identified as a factor causing delay in Yakub (2009) study.

'Unforeseen site/Ground Condition' was ranked as the fourth main cause of delays in major agricultural infrastructure projects. In contrast, Yakub (2009) identified 'Unforeseen site/Ground Condition' as the 33rd main cause of delay in road construction projects. This indicated that the ground condition had a more severe impact on the project duration in major agricultural infrastructure projects than in road construction projects.

'Necessary Change Orders/Variations' was identified as the fifth main cause of delays in major agricultural infrastructure projects. In contrast, Yakub (2009) identified 'Change Orders/Variations' as the 26th main cause of delay in road construction projects. This indicated that there are a higher percentage of variations in major agricultural infrastructure projects than road construction projects, and suggests that the scope of works specified in the contracts was poorly prepared.

The top 5 factors identified in this study were generally in agreement with the main factors identified in the literature review as causing time overrun in irrigation projects (Frimpong and Oluwoye, 2003; Inocencio et al., 2005; Jones, 1995). However, it was noted that 'Poor access to site' was not listed as a critical delay factor by those researchers. This may be because in other parts of the world, all weather roads were used to access the sites as against fair weather roads which were used in Guyana.

4.5 Proposed Methods of Minimising Project Delays

The methods advocated by Abdul-Rahman et al. (2006) and Yakub (2009) were modified for minimising delays in major agricultural infrastructure projects in Guyana. These methods were pre-tested in a pilot survey before adoption in the full-scale survey. The proposed methods of minimising construction delays are ranked in Table 5. A host of 29 methods were identified for minimising delays in major agricultural infrastructure projects.

In Guyana, a period of 12-18 months is usually allocated to complete construction works by the consultants and owners during the design stage of major agricultural infrastructure projects. This time along with the money allocated was generally considered to be insufficient by respondents, and this has resulted in major time overrun. Yakub (2009) made a similar

observation in road construction projects. It is thus essential that the consultants and owners allocate the appropriate project timeline and budget based on the actual work and the economic conditions anticipated when the works would be executed.

Once sufficient money is allocated at the design phase, this would ensure that adequate finance is available for the entire duration of the project. Moreover, a suitable contingency sum should be allocated to the projects to compensate for any unforeseen conditions that might be encountered. Otherwise, it would be very time consuming for the owners to solicit additional funds from parliament (or other sources), so as to complete the works.

In this study, several methods were identified in minimising delays in major agricultural infrastructure projects with reference to that in Guyana. The identification of effective methods would contribute to fill the literature gap, and would prove to be beneficial for practitioners and researchers.

Table 5. Proposed Methods of Minimising Delays in Construction/Infrastructure Projects

PROPOSED METHODS	Contractor		Owner		Consultant		Overall	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Allocation of sufficient time and money at the design phase.	4.67	3	4.75	1	4.48	8	4.63	1
Ensure adequate / available source of finance / cash flow for the entire project.	4.83	2	4.08	4	4.57	5	4.49	2
Multi-disciplinary / competent project team, e.g. project manager, contractor, client, consultants, supervisors, etc.	5	1	3.67	11	4.71	1	4.46	3
Proper site investigation by both consultant and contractor	4.5	4	4.08	4	4.43	11	4.34	4
Accurate initial cost estimates and drawings.	4	11	4.5	2	4.38	14	4.29	5
Improve access to site(s)	4.5	4	3.33	17	4.67	2	4.17	6
Comprehensive Work Plan.	3.83	12	4.25	3	4.38	14	4.15	7
Availability of materials, labour and equipment.	4.5	4	3.5	12	4.38	14	4.13	8
Site management and supervision	3.83	12	3.92	6	4.57	5	4.11	9
Financial incentives that would encourage meeting project deadline.	4.17	10	3.75	10	4.33	18	4.08	10
Rescheduling the activities within the available resources during construction	4.33	7	3.5	12	4.33	18	4.05	11
Use of appropriate construction methods	3.83	12	3.83	8	4.48	8	4.05	12
Competent personnel of consultant / designer	4.33	7	3.25	21	4.43	11	4.00	13
Adopting a new approach to contract award procedure by giving less weight to prices and more weight to the capabilities and past performance of contractors.	3.83	12	3.83	7	4.24	22	3.97	14
Proper project planning and scheduling	3.5	21	3.83	8	4.48	8	3.94	15
Competent and capable client's representative	4.33	7	3	24	4.43	11	3.92	16
Clear information and communication channels	3.83	12	3.5	12	4.29	20	3.87	17
Use of proper and modern construction equipment	3.33	24	3.42	15	4.62	3	3.79	18
Proper procurement of materials, labour and equipment	3.67	17	3	24	4.57	5	3.75	19
Effective conflict resolution	3.67	17	3.17	22	4.14	23	3.66	20
Use of Critical Path Method (CPM) Scheduling to monitor and control project activities.	3.5	21	3.33	17	4.1	24	3.64	21
Use of experienced subcontractors and suppliers.	3	25	3.42	15	4.38	14	3.60	22
Perform a preconstruction planning of project tasks and resources needs	3.67	17	2.58	27	4.29	20	3.51	23
Early warning meetings	2.67	17	3.33	17	4.1	24	3.37	24
Adopting new approaches to contracting such as Design-Build (D/B) and Construction Management (CM) type of contract.	3.5	21	3.08	23	3.14	29	3.24	25
Constructability Review and Value Engineering in Design Phase.	2.17	29	3.33	17	4.1	24	3.20	26
Regular progress meetings	2.5	26	3	24	3.62	3	3.04	27
Community involvement	2.5	26	2.5	28	3.43	27	2.81	28
Engineering workshops for farmers	2.5	26	2.33	29	3.33	28	2.72	29

5. Conclusions

A total of 84 factors that cause delays in major agricultural infrastructure projects were identified. The top 5 most significant factors contributing to project delays were: (1) weather condition; (2) poor access to site; (3) too optimistic estimate of project duration; (4) unforeseen site / ground condition; and (5) necessary change orders / variations.

There may be a number of similarities in the causes of project delays in both developed and developing countries. However, it was found that 'Poor access to site' would be a more significant factor that caused project delays in developing countries as compared with that in developed countries. This would explain the high ranking of the factor in this study.

In total, 11 categories of causes of project delays were identified. The category of client-related delays was ranked the most significant category. Moreover, a host of 29 methods of minimising project delays were proposed. The allocation of sufficient time and money at the design stage was identified as the most crucial method that could minimise delays.

This study also filled the literature gap with respect to ranking of the categories of delays, main causes of delays, and effective methods of minimising construction delays in major agricultural infrastructure projects, from the stakeholders' viewpoint (the owners, contractors, and consultants). Moreover, the critical stages identified emphasise the need for the completion of projects within schedule. Nevertheless, there were also several limitations (such as time constraints and limited human resources) in undertaking this study.

Furthermore, several recommendations could be made on addressing the problems associated with delays in major agricultural infrastructure projects in Guyana. These are:

1) Emphasis should be placed on improving the project management practices at the early stages of these projects.
2) An incentive clause should be incorporated into the contracts to reward contractors who deliver projects ahead of schedule, within budget and produce work of a high quality.
3) An Irrigation Schedule should be prepared and maintained.
4) Evaluation of the owner's system in dealing with major agricultural infrastructure projects, and
5) Identification of the sources that might lead to construction delays.

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