Journal of Construction in Developing Countries, Vol. 16(1), 19–40, 2011

Measuring the Performance of Guyana's Construction Industry Using a Set of Project Performance Benchmarking Metrics

*Christopher J. Willis[1] and Jeff H. Rankin[2]

Abstract: A study measuring the performance of Guyana's construction industry using a set of project performance benchmarking metrics was recently completed. The underlying premise of the study was that the aggregated performance of construction projects provides a realistic assessment of the performance of the construction industry, on the basis that construction projects are the mechanism through which the construction industry creates its tangible products. The fact that an influential government agency acted as owner of the study was critical to the data collection phase. The best approach for collecting project performance data in Guyana involves the utilisation of a researcher or team of researchers mining electronic and hard copy project documents. This study analysed approximately 270 construction projects to obtain an indication of the performance of guyana's construction industry. It was found that sea defence projects performed the worst, whereas health facility projects performed the best. The main implication of this is that sea defence projects are likely to be the least efficient and, given their critical nature, there is an argument for urgent performance improvement interventions.

Keywords: Benchmarking, Construction Industry, Guyana, Metrics, Performance Measurement

INTRODUCTION

Traditional methods of evaluating construction industry performance include measuring the percentage contribution of construction Gross Domestic Product (GDP) to national GDP and measuring growth in labour productivity. It appears that the former is a false measure of performance because, in reality, it provides only an indication of the level of economic activity generated by the industry, whereas the latter is an inaccurate assessment of performance because of the difficulties associated with its calculation (Rojas and Aramvareekul, 2003; Harrison, 2007). Alternative methods of evaluating construction industry performance include measuring its competitiveness (Momaya and Selby, 1998; Henricsson and Ericsson, 2005) and using industry-wide organisational and project performance benchmarking

[1]Department of Building, Civil and Enviromental Engineering, Concordia University, Montreal, CANADA
[2]Department of Civil and Environmental Engineering, University of New Brunswick, NB, CANADA
*Corresponding author: chriswillis2000@gmail.com

schemes. Benchmarking is a management technique that began in the copier industry, where it was pioneered by Xerox (McCabe, 2001); it is defined as a "systematic process of measuring and comparing an organisation's performance against that of other similar organisations in key business activities" (Costa et al., 2006). Benchmarking in construction is currently implemented at the organisational, project and industry levels, with developed countries such as the United States, the United Kingdom, Canada, Singapore, Australia, Hong Kong and Holland leading the way. Bakens (2005) discussed the benchmarking schemes used in the United Kingdom, the United States, the Netherlands, Australia, Singapore, Denmark and Hong Kong. Costa et al. (2006) discussed the benchmarking schemes used in Brazil and Chile, whereas Benjamin (2007) and Rankin et al. (2008) discussed the benchmarking schemes used in Canada. By benchmarking at the industry level, construction industries can measure and compare their performance and adopt the best practices to improve their performance.

Construction projects can be thought of as the mechanism by which the construction industry creates its outputs. These outputs include but are not limited to buildings, roads, water distribution systems and bridges. Additionally, a construction project can be thought of as the basic unit of a construction company (Levitt and Samelson, 1987), and therefore, in theory, it is one of the basic units of the construction industry. It is assumed that the analysis of lagging performance measures in the form of benchmarking metrics of multiple construction projects according to the parameters of cost, time, quality, safety and sustainability provides an indication of the performance of the construction industry. Using this premise, a study seeking to measure the performance of Guyana's construction industry using a set of project performance benchmarking metrics in conjunction with maturity modelling has been undertaken. In the study, the lagging performance of a large number of construction projects was measured, and the construction industry's maturity with respect to its key management and operation practices was assessed. The result gives an indication of the performance of the construction industry using both lagging and leading indicators of performance. Although lagging measures report on after-the-fact information, leading measures provide an early warning, which enables us to better ensure the desired positive lagging results. Leading measures can therefore be assumed to have a cause and effect relationship with lagging measures (Sinickas, 2006).

This paper reports on the first part of a study that measured the performance of Guyana's construction industry using a set of project performance benchmarking metrics. The objectives of the first part of the study were: (1) to establish and test a data collection method for the implementation of a sustainable construction industry performance benchmarking scheme in Guyana, (2) to test a set of project performance benchmarking metrics as a means of measuring and comparing the performance of Guyana's construction industry with that of other countries and (3) to establish indicators of the current performance of Guyana's construction industry. Based on the above objectives, this paper is structured such that it first presents a brief background on Guyana and its construction industry. The project types that were considered in the study are then briefly discussed, after which the results of the study are presented. The paper ends with a conclusion highlighting the main findings and implications of the results of the study on Guyana and its construction industry.

The target audience of this paper includes construction industry policy makers, researchers and industry practitioners. The findings of the study are useful to each of these groups in many ways; in particular, they will provide an indication of the current performance of Guyana's construction industry, which has never been published to date, and highlight important issues that must be considered in the implementation of a long-term construction industry performance benchmarking scheme in Guyana. Because Guyana is a developing country, it is expected that the issues uncovered and addressed in this study will be similar to those in other developing countries. Therefore, the findings of this study will be applicable and informative to policy makers, researchers and industry practitioners in other developing countries.

BACKGROUND – GUYANA'S CONSTRUCTION INDUSTRY

Guyana is an independent nation located on the northern coast of South America. It is the only English-speaking country in South America and has a land mass of approximately 216,000 km^2 with a population of approximately 770,000 (CIA World Fact Book, 2009). The World Bank classifies Guyana as a developing country and, in addition, as a heavily indebted poor nation (World Bank, 2007). The importance of Guyana's construction industry is emphasised in the country's National Development Strategy (NDS), which places emphasis on the construction of physical infrastructure as a means of aiding the resettlement of the country's population from the coast to the interior (National Development Strategy, 2000a). Additionally, the construction industry is charged with providing the necessary infrastructure that will allow for the production of food and enhance the extraction and processing of the country's vast natural resources. The construction industry is also tasked with providing and maintaining a land-based trade route with Brazil that is expected to greatly benefit the economy (National Development Strategy, 2000b). The importance of Guyana's construction industry is also highlighted in the World Bank (2007) country report, which mentions the need for Guyana to improve the standard of living of its citizens by improving and expanding its insufficient physical infrastructure in the areas of water distribution, health care, education and housing.

At present, Guyana's construction industry seems to be performing poorly, and for this reason it has often been the subject of debate in articles from Guyana's print media such as Stabroek News (2007a, 2007b, 2007c and 2009) and the Guyana Chronicle (2009). In addition, the perceived poor performance of Guyana's construction industry has often been highlighted through sporadic subjective criticisms by local industry observer groups, such as the Guyana Association of Professional Engineers (GAPE), and through small numbers of graduate research theses such as Willis (2006) and a lone journal publication (Willis and Lewis, 2009). To date, there have been no recognised studies focusing specifically on the performance of Guyana's construction industry; thus, a formal study measuring the performance of Guyana's construction industry is justified.

BACKGROUND – PROJECT TYPES

A total of five project types from the public sector were considered in this study including water supply projects, secondary road projects, sea defence projects, health facility projects and education facility projects. These project types were selected as they reflect the current and future thrust of development in Guyana and are therefore ideal for measuring and benchmarking the current and future performance of Guyana's construction industry. Table 1 summarises the main attributes of each project type in terms of the scope, main materials, location, and construction process concomitant with each of them.

A summary of the number of projects according to each project type considered in the study is shown in Table 2. A breakdown of projects by contract size is shown, where large projects are those with a contract size greater than 10 million Guyana dollars, medium size projects are those with a contract size between three million and 10 million Guyana dollars and small projects are those with a contract size less than three million Guyana dollars. To convert Guyana dollars to US dollars, the exchange rate of US$1 = G$203 (Bank of Guyana, 2009) was used. Of the five project types, water supply projects were the greatest in number (102), whereas health facility projects accounted for the fewest projects

(13). In addition, water supply projects were predominantly small and medium projects, whereas the other projects were predominantly large. Regarding average contract cost, education facility projects were the most expensive, whereas water supply projects were the least expensive. It is important to note that the projects were all of the design-bid-construct contracting method and were executed by predominantly local contractors who were supervised mainly by local consultants.

Table 1. Summary of the Main Attributes of the Five Project Types Considered in this Study

Project Type	**Attributes**
Water Supply Projects	Scope: Construction of water distribution pipelines to transport drinking water from treatment facilities to households.
	Main materials: PVC pipes (ranging from 200 mm to 300 mm in diameter), fittings and white sand for backfilling excavated trenches.
	Location: The majority of water supply projects are located on Guyana's coast, which is flat terrain.

Table 1. *(continued)*

Project Type	**Attributes**
	Construction process: A backhoe is used to excavate a trench that is then backfilled with approximately 300 mm of white sand, after which the new pipeline is placed. The construction process ends with pressure testing of the new pipeline and backfilling around the new pipeline, reusing the excavated material.
Secondary Road Projects	Scope: Construction and reconstruction of minor low traffic roadways. Construction includes placing new base material and wearing surface, which is usually asphaltic concrete or double bituminous surface treatment (DBST).
	Main materials: White sand, crusher run, asphalt and fine and coarse aggregate.
	Location: Coastal villages and residential areas.
	Construction process: A grader and pneumatic roller are used to place base course material. The wearing surface is placed either by hand (in the case of DBST) or with a mechanical asphalt spreader.

(continued)

Table 1. *(continued)*

Project Type	Attributes
Sea Defence Projects	Scope: Construction of sea defence structures to hold back or prevent the Atlantic ocean from flooding the coast, which is approximately seven feet below sea level at high tide.
	Main materials: Large granite boulders, geotextile fabric with high strength and durability.
	Location: The coastline of Guyana where the landmass meets the Atlantic ocean.
	Construction process: Large excavators and draglines place and wrap granite boulders in place using geotextile fabric. Construction is usually restricted to periods of low tide.
Health Facility Projects	Scope: Construction of hospitals, community health centres and clinics. Buildings are usually one to two storeys with no basements, elevators or automatic doors.
	Main materials: All main materials are local and include concrete hollow blocks, timber (hardwood from the rainforest), and galvanised roof sheeting.
	Location: Located primarily inland, i.e., the interior or jungle region of Guyana.
	Construction process: The construction process and techniques are low in mechanisation. Due to the relatively isolated locations of these projects, most project personnel are inexperienced individuals drawn from nearby surrounding villages and communities.
Education Facility Projects	Scope: Construction of schools that are one to three storeys in height. Buildings are usually one to two storeys with no basements, elevators or automatic doors.
	Main materials: All main materials are local and include concrete hollow blocks, timber (hardwood from the rainforest), and galvanised roof sheeting.
	Location: Located primarily on the coast of Guyana where the largest percentage of the population has settled.
	Construction process: The construction process and techniques are low in mechanisation.

Source: Willis (2010)

Table 2. Summary of the Projects that were Part of the Study

Project Types	Total No. of Projects	Breakdown of Project By Contract Size			Average Contract Cost (G$)
		Large	Medium	Small	
Water Supply Projects	102	25	30	47	$17,171,163
Secondary Road Projects	72	37	32	3	$45,458,260
Sea Defence Projects	27	26	0	1	$53,570,328
Education Facility Projects	34	29	4	1	$67,880,828
Health Facility Projects	13	9	4	0	$25,902,260

Source: Willis (2010)

PROJECT PERFORMANCE BENCHMARKING METRICS

The crux of this study was the manipulation of project performance data using a set of performance metrics. The performance metrics were derived from a previous study done by the Canadian Construction Innovation Council (CCIC), which measured the performance of the Canadian construction industry (CCIC, 2007). In turn, the CCIC metrics were derived from the Construction Industry Institute (CII) benchmarking metrics and the UK's Key Performance Indicators (KPIs). The main reason for using the CCIC metrics was to allow for a comparison between the construction industries of Guyana and Canada. In addition, the CCIC benchmarking metrics were a refined and improved version of CII and KPI metrics. The project performance data utilised by the metrics were derived from the various phases of a construction project as depicted in the project timeline (Figure 1). This project timeline is an adaptation of the one used by the CCIC (2007) study, and the bold section indicates the project phases from which the performance data were derived to measure the performance of Guyana's construction industry. The reason that the project performance data were derived mainly from phases C to F (i.e., from "begin procurement" to "end of defects liability period") was because a preliminary assessment of public sector construction projects in Guyana revealed that the planning and design phases are often done many years in advance of the tendering phase. This makes it extremely difficult to locate data originating from these early phases. In addition, the latter phase leading to the "end of lifetime of project", i.e., from F to G, was omitted because there are no public infrastructures in Guyana that have been officially declared as having reached the end of their lifetime at present.

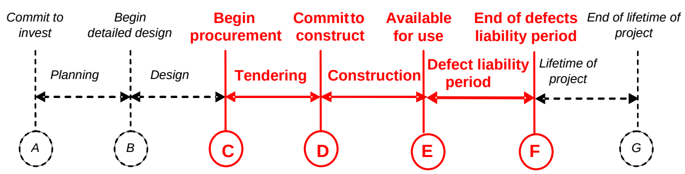

Figure 1. Project Timeline Applicable for Measuring the Performance of Construction Projects in Guyana
Source: Willis (2010)

The project performance metrics utilised in this study are listed in Table 3. A definition of each metric is provided along with the formulae used to calculate the numeric values of the metrics. A total of five project performance metrics were utilised; two measured project cost performance, two measured project time performance and one measured performance with respect to changes in project scope. Omitted from the study were metrics measuring quality, safety, satisfaction and sustainability performance. Although there are metrics to measure these parameters, they are qualitative in nature and require project participants to provide input by answering questionnaires. Unfortunately, given Guyana's high rate of migration of skilled professionals (International Monetary Fund, 1999), especially civil engineers who leave to work in various Caribbean territories, it was difficult to locate the participants of the projects considered in this study to measure the four parameters of performance.

Table 3. Performance Metrics Used to Benchmark the Performance of Guyana's Construction Industry

No	Metric	Metric Definition	Formula
1	Cost		
1.1	Cost predictability-construction	Change between the actual construction cost at Available for Use (point E) and the estimated construction cost at Commit to Construct (point C), expressed as a percentage of the estimated construction cost at Commit to Construct (point C).	(actual construction cost-estimate construction cost) / (actual construction cost)
1.2	Cost per unit	Average cost for the product constructed (e.g. dollars per kilometre of pipe, dollars per m2 of floor space) Point F.	(tendered cost) / (capacity measurement)
2	Time		
2.1	Time predictability-construction	Change between the actual construction time at Available for Use (Point E) and the construction time at Commit to Construct (Point C), expressed as a percentage of estimated construction time at Commit to Construct (Point C)	(actual construction time – estimate construction time)/ (actual construction time)

(continued)

Table 3. *(continued)*

No	Metric	Metric Definition	Formula
2.2	Time per unit	Average time for the product constructed (e.g. months per kilometre of pipe, months per m2 of floor space)	(contract time for construction) / (capacity measurement)
3	Scope		
3.1	Cost for change	Change, attributable to client approved change orders originating from either the client's representative or contractor, between the actual construction cost at Available for Use (point E) and the estimated construction cost at Commit to Construct (point C), expressed as a percentage of the estimated construction cost at Commit to Construct (point C).	(approved cost for change originating from either the client or contractor) / (tendered cost)

Source: Willis (2010)

DATA COLLECTION – METHOD

The data collection for this study was done over a period of approximately four months from December 2008 to March 2009. Performance data were collected from approximately 270 projects that were completed between 2003 and 2008. All projects utilised the design-bid-construct contracting method. Prior to the official commencement of the data collection phase of the study, discussions were held with several senior construction industry players. In these discussions, it was discovered that, to successfully implement this study, especially the data collection phase, it was necessary to have a government agency act as a "champion" or owner of the study. After considering the structure and operation of Guyana's construction industry as it concerns public sector projects (i.e., the way in which these projects were initiated, executed and monitored) and the varying levels of clout and power of the different government agencies, it was determined that the Ministry of Finance was best suited to act as the owner of this study.

As owner of this study, the Ministry of Finance undertook the task of requesting the required data from pertinent ministries and agencies. In reality, a compromise was achieved where access was given to the researcher to peruse all relevant documents (both hardcopy and electronic) and to view electronic databases whenever they existed and were being utilised, instead of the government agencies assembling the data and handing it over. Typically, data were firstly collected from electronic sources whenever these existed. In most cases, this was done by copying the electronic versions of various documents and mining them at an offsite location. Once this was done, hardcopy documents were mined to locate data that was not present in the electronic documents and to validate some of the data from the electronic documents. Whenever there were discrepancies or contradictions between the electronic documents and the hardcopy documents, the data from the hardcopy documents were considered to be truthful and overruled the data from the electronic documents. This was because in many instances the electronic documents were draft documents and not final documents, whereas the hardcopy documents were mainly final documents that were agreed upon by all the contracting parties and had been signed off and dispatched to these parties. In essence, the hardcopy documents were official contract and project management documents, whereas the electronic version documents were not.

A list of the electronic and hardcopy documents and the types of data they provided is shown in Table 4. Correspondences regarding project planning provided data on estimated construction time and cost. Project design reports provided data on the design cost, estimated construction time, estimated construction cost and the capacity size of the project. Construction contracts and drawings provided data on contract cost, time and capacity size, whereas the consultants' monthly reports and the contractors' final payment certificates provided data on actual construction time, actual construction cost, cost for changes and the occurrence of safety incidents. Correspondences during project execution provided data concerning the cost for changes and the time required for changes as they occurred.

Table 4. A List of Electronic and Hard Copy Documents along with the Types of Project Performance Data they Provided

Document (Electronic & Hard Copy)	Types of Data
project planning correspondences project design reports	estimated construction time, estimated construction cost, design cost, estimated construction time, estimated construction cost, capacity size
construction contracts	contract cost, contract time, capacity size
contract drawings	capacity size
consultants' monthly reports	actual construction cost, actual construction time, cost for change (scope), time for change (scope), safety incidents
contractors' final payment certificates	Actual construction cost, actual construction time, cost for change (scope)
project execution correspondences	Cost for changes (scope), time for change (scope)

Source: Willis (2010)

The ease with which the various types of data were collected is highlighted by the diagram shown in Figure 2, which illustrates the spectrum and ease of collecting the various types of project performance data. The types of data that were collected in the study are highlighted and their sources are shown in italics. Data originating from project execution/monitoring correspondences and documents were the easiest to obtain, whereas data originating from facility operation records were the most difficult to obtain. Although data on project quality has been omitted from this study because of the non-availability of project participants due to migration, administering quality surveys and interviews was the second easiest method of collecting project performance data in Guyana based on required effort and time. Regarding the project performance data that was collected and used in this study, data on estimated construction time was the most difficult to collect because project feasibility and planning in Guyana is usually done many years in advance of project execution, which makes this type of data difficult to locate.

RESULTS

This section discusses the results of measuring the performance of Guyana's construction industry. The results are presented and discussed according to each of the five performance metrics; for each metric, the performance of the five project types was analysed and compared. The analysis and comparison were done using radar graphs, which plot and compare the values of the various metrics. In constructing the radar graphs, it was necessary to normalise and invert the values derived for the various performance metrics. This normalisation allowed the values representing performance to be plotted on a common scale, whereas the inversion was done to adhere to the convention that higher magnitudes are indicative of better performance. The cost per unit metric can be used as an example of how the normalisations and inversions were done. This metric is calculated using the formula: contract cost/capacity measurement. Clearly, the lower the value of cost per unit, the better the performance of the project type. For the purpose of the radar graph, the values of cost per unit are first normalised, i.e., for a specific project type, each value of cost per unit is divided by the maximum cost per unit of that project type. These values are used to calculate the average cost per unit of the project type, which is then inverted. In Microsoft Excel, this is achieved using the general formula '1- AVERAGE (G1##:G2##)', i.e., the average of the normalised values is subtracted from 1.

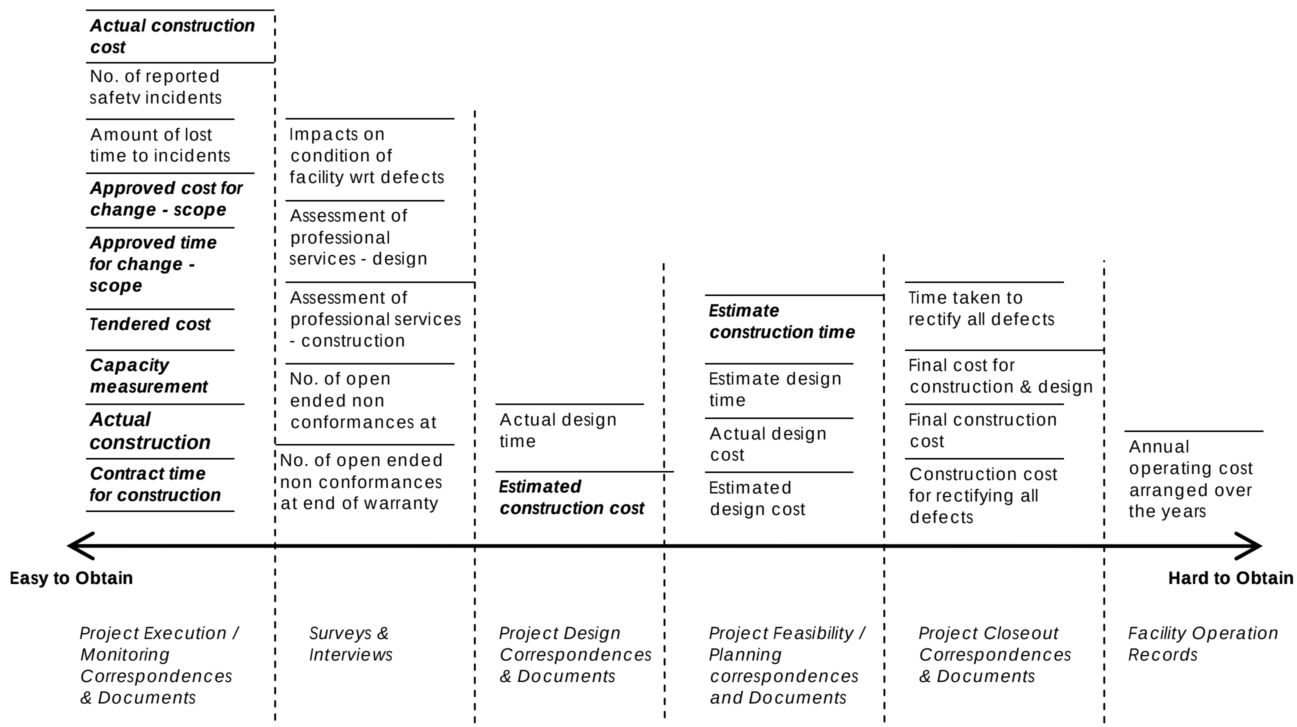

Figure 2. Diagram Showing the Spectrum and Ease of Collecting Various Types of Project Performance Data in Guyana
Source: Willis (2010)

When possible, reasons for specific results concerning the measured performance of Guyana's construction industry are provided. An important point to note while reading this section is that the unit of measurement for time is days, whereas the unit of measurement for cost is Guyana dollars.

COST PREDICTABILITY – CONSTRUCTION

Figure 3 is a radar graph comparing the cost predictability performance of the five project types. The values on the radar graph represent the normalised average cost predictability whereby larger magnitudes indicate better performance. The normalised average cost predictability of each project type is compared against the statistical upper quartile or upper range of cost predictability of each of the five project types, which acts as an 'efficiency' or best performance frontier. We observed that health facility projects perform best, because their average performance is closest to their best performance frontier. Secondary road projects have the second best average performance, followed by water supply projects, education facility projects and sea defence projects.

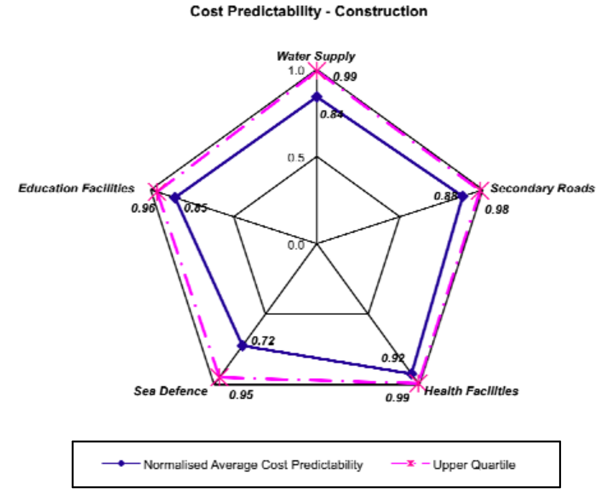

Figure 3. Radar Graph Comparing 'Cost Predictability - Construction' between the Five Project Types
Source: Willis (2010)

The above radar graph highlights that, regarding the performance of Guyana's construction industry with respect to the cost predictability-construction metric, sea defence projects are performing the worst in comparison to the other project types. To get a clearer understanding as to why this is the case, an in depth investigation of the estimated and actual construction costs of the projects considered under each project type was done. The findings of this investigation are shown in Table 5, which illustrates that there is a general tendency for construction project costs to be overestimated, thereby resulting in projects' actual construction costs being less than what was budgeted. In other words, over budgeting for the execution phase of construction projects appears to be the dominant practice in Guyana's construction industry. This was the most pronounced for the sea defence projects and least pronounced for the water supply projects. Instances of estimated construction costs being the same as the actual construction costs were greatest for health facility projects (38%), followed by water supply projects (28%), secondary road projects (19%), education facility projects (15%) and sea defence projects (10%).

The results in Table 5 appear to be in agreement with the findings of other construction industry performance measurement studies. In particular, there is agreement with the findings of Fisher et al. (1995), which showed that there was a general tendency to overestimate total construction costs in the US construction industry.

TIME PREDICTABILITY-CONSTRUCTION

The performance of the five project types with respect to the time predictability-construction metric is shown in Figure 4. The values of time predictability are inverted average values whereby higher magnitudes represent good performance and lower magnitudes represent poor performance. The health facility project type performs best, because it is closest to its best performance frontier. This is followed by the secondary road project type, the water supply project type, the sea defence project type, and lastly the education facility project type, which performs the worst.

Table 5. Summary of Differences between Estimated and Actual Construction Costs for the Five Project Types

	Water Supply	Secondary Roads	Health Facilities	Sea Defence	Education Facilities
Estimated > Actual	46 (51%)	29 (56%)	7 (54%)	17 (85%)	21 (64%)
Estimated = Actual	25 (28%)	10 (19%)	5 (38%)	2 (10%)	5 (15%)
Estimated < Actual	19 (21%)	13 (25%)	1 (8%)	1 (5%)	7 (21%)

Source: Willis (2010)

To better appreciate and understand the underlying reasons for the trend shown in the above radar graph, a deeper investigation comparing the estimated and actual construction times for the projects of the five project types was done. Table 6 summarises the main findings of this investigation, which revealed that there is a tendency in Guyana's construction industry for the construction project time to be under estimated or for the construction project to be under budgeted. This was more pronounced for health facility, sea defence and education facility project types. In cases when the estimated construction time was the same as the actual construction time, water supply projects led the way, with 30% of projects satisfying

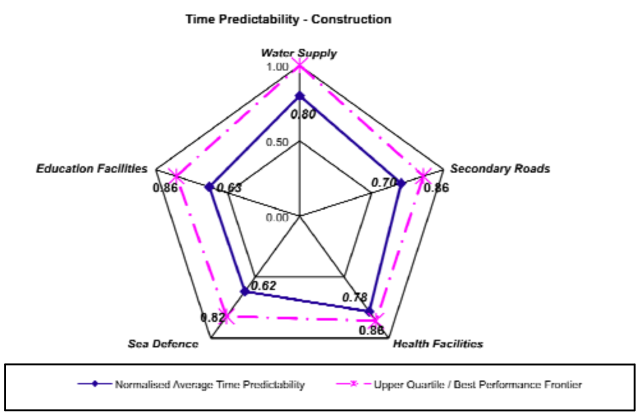

Figure 4. Radar Graph Comparing the Five Project Types According to 'Time Predictability-Construction'
Source: Willis (2010)

this criteria, followed by sea defence projects (24%), secondary road projects (19%), health facility projects (10%) and education facility projects (0%).

Table 6. Summary of Differences between Estimated and Actual Construction Time

	Water Supply	Secondary Roads	Health Facilities	Sea Defence	Education Facilities
Estimated > Actual	13 (16%)	9 (16%)	2 (20%)	1 (5%)	8 (29%)
Estimated = Actual	22 (30%)	11 (19%)	1 (10%)	5 (24%)	0 (0%)
Estimated < Actual	41 (54%)	37 (65%)	7 (70%)	15 (71%)	20 (71%)

Source: Willis (2010)

COST FOR CHANGE – PROJECT SCOPE

Regarding the performance of Guyana's construction industry with respect to the cost for change metric, the project scope is highlighted in the radar graph shown in Figure 5. Average normalised values representing the cost for scope changes are compared against the lower range or statistical lower quartile values for each project type; this acts as a best performance frontier for each project type. In analysing the radar graph, we see that the distance of the average cost for scope changes from the performance frontier is greatest for water supply projects and least for health facility projects. This implies that, of the five project types, water supply projects are underperforming the greatest in relation to the best performance frontier, whereas the performance of the health facility project type is the best.

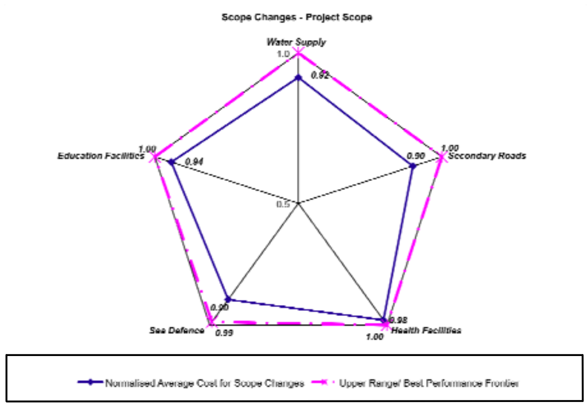

Figure 5. Radar Graph Comparing the Average Cost for Scope Changes of the Five Project Types Against their Best Performance Frontier
Source: Willis (2010)

Based on the findings of the above radar graph, we can argue that, in Guyana's construction industry, health facility projects perform best with respect to the cost for changes-project scope metric, followed by education facility projects, secondary road projects, sea defence projects and water supply projects, which performed the worst. This result was expected because the scope of building projects is easier to define and control during project execution. Due to the limitations of the data collected for this metric, it was not possible to determine the sources of the scope changes, i.e., whether it was contractor-, consultant- or client-initiated. Knowing this information would have provided a better understanding as to the extent to which these participants influenced the performance of the construction industry with respect to this metric.

COST PER UNIT

The performance of Guyana's construction industry with respect to the cost per unit metric is shown in Figure 6, which is a radar graph comparing the average cost per unit of the five project types against their best performance frontier. The values of average cost per unit have been normalised and inverted so that higher magnitudes represent good performance (i.e., lower costs per unit), whereas lower magnitudes represent poor performance (i.e., higher costs per unit). The best performance frontiers are the statistical lower quartile values, which have also been inverted so that larger magnitudes represent good performance. In comparing the proximity of the points of normalised average cost per unit in relation to the points on the best performance frontier, we see that the average cost per unit of secondary road projects and water supply projects are closest to their best performance frontiers. However, the average cost per unit of the sea defence project type is furthest from its best performance frontier. This implies that, of the five project types, sea defence projects perform the poorest with regard to cost per unit. This finding is validated to an extent as sea defence projects are more energy intensive than the other project types given the nature of the work involved. In addition, sea defence projects, being more exposed to various weather elements, are more costly to account for increased risks and uncertainties in their execution.

TIME PER UNIT

The radar graph shown in Figure 7 compares the time per unit performance of the five project types. The time per unit values have been normalised and inverted, as was done for the cost per unit values, such that larger magnitudes reflect good performance. Based on the proximity of the average time per unit values to their best performance frontiers, secondary road and education facility project types have the best time per unit performance whereas water supply and sea defence projects have the lowest time per unit performance.

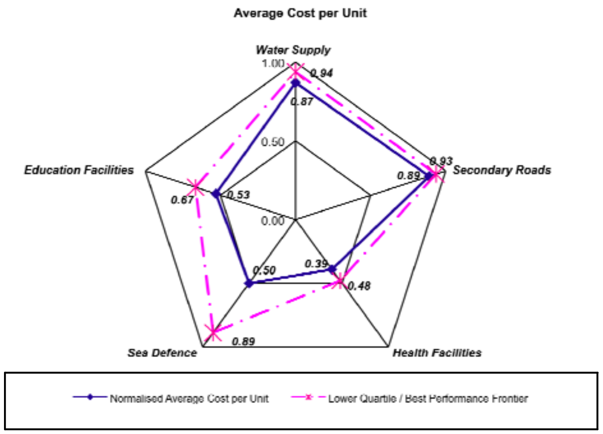

Figure 6. Radar Graph Comparing the Average Cost Per Unit of the Five Project Types against their Best Performance Frontier
Source: Willis (2010)

Regarding the cost per unit metric, the results of the time per unit metric are validated to an extent based on the nature of the project types and the factors affecting their performance. Clearly, compared with the building projects, sea defence and water supply projects are subject to a greater number of external influences that are difficult to plan for and control.

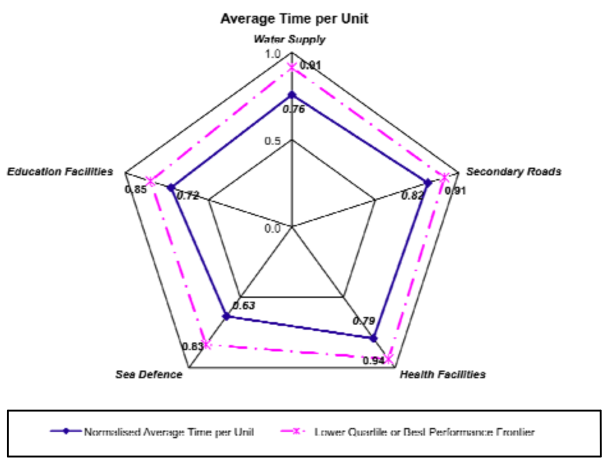

Figure 7. Radar Graph Comparing the Average Time Per Unit Performance of the Project Types against their Best Performance Frontier
Source: Willis (2010)

GENERAL SUMMARY OF THE PERFORMANCE OF GUYANA'S CONSTRUCTION INDUSTRY

A summary of the performance of Guyana's construction industry with respect to the five project types is shown in Table 7. The values indicate the performance rank of each project type in terms of the five project performance metrics. As such, sea defence projects have the worst overall performance because this project type performs the worst in three of the five performance metrics. However, health facility projects seem to have the best overall performance because this project type has the best performance in three of the five performance metrics considered.

It can be argued that the above results were expected because health facility projects, which are building projects, are easier to control and are less affected by uncontrollable influences, such as changing weather and environmental conditions. In addition, the design of health facility projects is standardised to a certain degree, and the construction materials and methods utilised are usually the same. However, this argument cannot be fully applied to sea defence projects as these are greatly influenced by uncontrollable conditions, such as ocean tides and poor weather. Additionally, sea defence projects are likely to have a greater amount of constructability issues and variations in design, which are likely to negatively affect their cost and time performance.

Table 7. Summary of the Performance of Guyana's Construction Industry Based on Project Type

	Performance Metrics				
Project Type	Cost Predictability-Construction	Time Predictability-Construction	Cost for Change-Project Scope	Cost per Unit	Time per Unit
Health Facility	1	1	1	3	3
Education Facility	3	5	2	4	2
Secondary Roads	2	2	5	1	1
Water Supply	4	3	3	2	4
Sea Defence	5	4	4	5	5

Source: Willis (2010)

CONCLUSION

This paper reports the first official study measuring the performance of Guyana's construction industry using a set of lagging performance measures in the form of project performance benchmarking metrics. Because data were collected from approximately 270 projects that were executed between 2003 and 2008, the results are representative of the performance of Guyana's construction industry for this time period. The following are concluding remarks concerning the objectives of the study.

In establishing and testing a data collection method for the implementation of a sustainable construction industry performance measurement and benchmarking scheme, this study found that a method based on a researcher (or team of researchers) mining electronic and hard copy project documents is appropriate for Guyana. The alternative–having project execution agencies provide the various types of project performance data–is not feasible, as was confirmed by this study. In addition, the role of the Ministry of Finance as 'champion' or 'owner of the study' was essential to the success of the data collection phase. It is therefore recommended that the Ministry of Finance be retained as owner of future construction industry performance measurement studies in Guyana. The approach of having an influential agency or ministry act as the principal owner of the study may also be suitable for other developing countries with similarly structured governments and construction industries.

This study tested a set of five project performance benchmarking metrics as a means of measuring the performance of Guyana's construction industry and ultimately allowing for a comparison with construction industries of other countries, especially Canada. Of the five project performance metrics, it appears that the cost predictability construction and time predictability construction metrics are informative and useful in a number of ways. The cost per unit and time per unit metrics do not account for differences in design and project characteristics, but they may still be suitable as industry level performance measures when detailed aspects of projects are expected to be ignored. Due to the limitations of project performance data records in Guyana, the cost for change-project scope metric provided a limited understanding of the changes to project cost due to changes in project scope. An improvement in detailed record keeping is therefore required for a thorough understanding of the origins of changes in project cost due to changes in scope.

Lagging indicators of the current performance of Guyana's construction industry were successfully established for each of the five project types considered in this study. The sea defence project type appears to have the worst performance in comparison to the other project types, whereas the health facility project type appears to have the best performance. This finding was expected given the differences in the characteristics and the influences on the execution of the project types that were considered. The main implication of the performance results for Guyana and its construction industry is that the implementation of sea defence projects is the least efficient of the five project types and is therefore likely to waste the most resources. Given the critical nature of sea defence projects, it logically follows that interventions should be made to improve the performance of this project type. The indicators of performance are useful because they provide national development planners and construction industry policy makers with a gauge of the performance of construction projects that create the physical infrastructure that is critical to the country's development thrust.

Future work associated with this area of research includes comparing the performance of Guyana's construction industry with that of other developing countries and linking the measured performance of the industry with an assessment of its maturity. The final research product is expected to be the comparison of the project performance of Guyana's construction industry with that of Canada's construction industry in the context of the maturity of the two construction industries.

REFERENCES

Bakens, W. (2005). *International Review of Benchmarking in Construction: Executive Summary*. Parkside Drive, Watford: Roger Courtney Construction Innovations Ltd.

Bank of Guyana. (2009). *Exchange Rates*. [Online]. Available at: http://www.bankofguyana.org.gy/ [Accessed 25 June 2009].

Benjamin, A. (2007). *Benchmarking Performance in Construction: A Case Study of the Canadian Public Sector*. M.Sc Project Report. University of Alberta, Canada.

CCIC. (2007). *Measuring the Performance of the Canadian Construction Industry*. Pilot Project Final Report. Canadian Construction Innovation Council, Toronto, Canada

CIA. (2009). World Fact Book. *Country Profile: Guyana*. [Online]. Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/gy.html [Accessed 2 February 2009].

Costa, D.B., Formoso, C.T., Kagioglou, M. Alarcon, L.F. and Caldas, C. (2006). Benchmarking initiatives in the construction industry: Lessons learned and improvement opportunities. *Journal of Management in Engineering*, 22(4): 158–167.

Fisher, D., Miertschin, S. and Pollock, D. (1995). Benchmarking in construction industry. *Journal of Management in Engineering*, 11(1): 50–57.

Guyana Chronicle. (2009). Tough New Measures for Contractors, Consultants: President Warns Permanent Secretaries Can Loose Jobs. [Online]. *Guyana Chronicle*. 3 April 2009. Available at: http://www.guyanachronicle.com/ARCHIVES/archieve%2003-04-09.html#Anchor-------------39430 [Accessed 2 February 2009].

Harrison, P. (2007). Can measurement error explain the weakness of productivity growth in the Canadian construction industry? *International Productivity Monitor*, 14(Spring): 53–70.

Henricsson, P. and Ericsson, S. (2005). Measuring Construction Industry Competitiveness: A Holistic Approach. *Proceedings: The Queensland University of Technology Research Week International Conference*. Brisbane, Australia, 4–8 July.

International Monetary Fund. (1999). *How Extensive is the Brain Drain?* [Online]. Available at: http://www.imf.org/external/pubs/ft/fandd/1999/06/caringt.htm [Accessed 2 February 2009].

Levitt, R. and Samelson, N. (1987). *Construction Safety Management*. New York: McGraw – Hill Inc.

McCabe, S. (2001). *Benchmarking in Construction*. London: Blackwell Science Ltd.

Momaya, K. and Selby, K. (1998). International Competitiveness of the Canadian Construction Industry: A Comparison with Japan and the United States. *Canadian Journal of Civil Engineering*, 25(4): 640–652.

National Development Strategy. (2000a). *NDS: Overview*. [Online]. Available at: http://www.sdnp.org.gy/nds/overview.pdf [Accessed 24 May 2007].

________. (2000b). *NDS: GDP by Activity at Constant Factor Cost*. [Online]. Available at: http://www.sdnp.org.gy/nds/gdp2.html [Accessed 24 May 2007].

Rankin, J., Robinson-Fayek, A., Meade, G., Hass, C. and Manseau, A. (2008). Initial metrics and pilot program results for measuring the performance of the Canadian construction industry. *Canadian Journal of Civil Engineering*, 35(9): 894–907.

Rojas, E. and Aramvareekul, P. (2003). Is construction labour productivity really declining? *Journal of Construction Engineering and Management, ASCE*, 129(1): 41–46.
Sinickas, A. (2006). Stay on track with leading measures. *Sinickas Communication Management*, 10(6): 12–13.
Stabroek News. (2007a). Govt. Awaiting CDB Approval to Extend Four Lane Highway: Willis says 'not really' satisfied with work. [Online]. *Stabroek News*. Available at: http://www. stabroeknews.com/index.pl/article_archive?id=51512267 [Accessed 19 May 2007].
Stabroek News. (2007b). Construction Industry Operating in Flagrant Disregard for Building Standards: Rodrigues. [Online]. *Stabroek News*. Available at: http://www. stabroeknews.com/index.pl/article_archive?id=56496000 [Accessed 24 May 2007].
Stabroek News. (2007c). EU Funded Housing Project Scaled Back Due to High Construction Costs. [Online]. *Stabroek News*. Available at: http://www.stabroeknews.com/ index.pl/article_archive?id=56506344 [Accessed 24 May 2007].
Stabroek News. (2009). Contractors, Consultants to be Held to Rigid Standards: Late penalties to be instituted. [Online]. *Stabroek News*. Available at: http://www.stabroeknews. com/2009/news/local/04/04/contractors-consultants-to-be-held-to-rigid-standards/ [Accessed 2 June 2009].
Willis, C.J. (2006). *A Comparison of Highway Construction Costs between Guyana and Trinidad as Faced by a Trinidadian Contracting Firm.* M.Sc(Eng) Research Project. University of the West Indies, St. Augustine, Trinidad.
________. (2010). *Measuring the Performance of the Construction Industry through the Use of Project Performance Benchmarking Metrics and Maturity Modeling*. Doctoral thesis. University of New Brunswick, Canada.
Willis, C.J. and Lewis, T.M. (2009). A comparison of highway construction costs between Guyana and Trinidad as faced by a Trinidadian contracting firm. *Journal of Construction Procurement*, 13(1): 14–23.
World Bank. (2007). *Guyana Country Brief*. [Online]. Available at: http://web.worldbank.org/WBSITE/EXTERNAL/ COUNTRIES/LACEXT/GUYANAEXTN/0,,menuPK:328284~page PK:141132~piPK:141107~theSitePK:328274,00.html [Accessed 19 May 2007].