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Measuring the Maturity of Guyana's Construction Industry Using the Construction Industry Macro Maturity Model (CIM3)

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Abstract: The newly developed Construction Industry Macro Maturity Model (CIM3) was used to measure the maturity of Guyana's construction industry. The CIM3's assessment provides a leading indication of performance by relating the maturity of a set of management and operation key practices in the construction industry to the achievement of various performance objectives that lead to the realisation of the construction industry's performance goals. The implementation of the CIM3 in Guyana relied upon the use of an expert group of construction industry professionals who were elicited to provide the input information for the model. It was found that Guyana's construction industry is least mature with respect to health and safety management and most mature with respect to cost management. Overall, Guyana's construction industry is immature, and a translation of its maturity to represent the level of realisation of its combined performance goals indicates that its lagging or after-the-fact performance indicators are likely to be poor.

Keywords: CIM3, Construction Industry, Guyana, Maturity, Performance

INTRODUCTION

In an effort to provide a better approach to the measurement, comparison and interpretation of the performance of a country's construction industry, researchers at the University of New Brunswick developed an innovative performance measurement framework that utilises maturity modelling and a set of project performance benchmarking (Willis and Rankin, 2008). The maturity model developed as part of this framework is referred to as the Construction Industry Macro Maturity Model (CIM3), and is based on an adaptation of the concept of process maturity. While maturity modelling has been extensively applied in the software manufacturing industry, most notably as the Capability Maturity Model (CMM) and in the area of project management as the Organisational Project Management Maturity Model (OPM3), the Portfolio, Program and Project Management

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Maturity Model (P3M3) and the PRINCE2 Maturity Model, its use within the construction industry is still in its infancy.

A recent paper by Willis and Rankin (2009) reported on the development and theoretical underpinnings of the CIM3. This paper reports the implementation of the CIM3 in Guyana, a developing country, as part of a larger study to measure the performance of its construction industry and to prove that there is a relationship between the maturity and performance of a country's construction industry. To prove this, the CIM3 is implemented in both a developing country (Guyana) and a developed country (Canada). The objectives of this paper are as follows: (1) to provide a brief background on Guyana and its construction industry, (2) to provide a brief overview of the CIM3, (3) to briefly highlight aspects of the implementation of the CIM3 in Guyana and (4) to present and discuss the resulting maturity assessment provided by the CIM3. This paper is expected to be of interest to construction industry policy makers, researchers and practitioners because it will provide these groups with an understanding of the level of advancement of Guyana's construction industry in terms of its management and operation key practices. These groups will be provided with an alternative perspective of measuring and interpreting the performance of the construction industry through the use of leading measures as opposed to lagging measures. The maturity framework and method of assessment used in this study will be applicable to both developing and developed countries. In fact, the CIM3 has recently been applied in Canada, and the results will be presented in a subsequent paper.

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 and a population of approximately 770,000 (CIA World Fact Book, 2009). The World Bank classifies Guyana as a developing country or, more accurately, 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). In addition, 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. In addition, the construction industry is tasked with providing and maintaining a land-based trade route with Brazil, which 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 and expand its insufficient physical infrastructure in the areas of water distribution, health care, education and housing to improve the standard of living of its citizens.

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 the 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 by small numbers of graduate research theses, such as that by 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. To this end, a formal study to measure the maturity of Guyana's construction industry is necessary.

BACKGROUND – CONCEPT OF MATURITY MODELLING

Maturity modelling, more specifically, process maturity modelling, has its genesis in the software manufacturing industry (Finnemore et al., 2000) and is based on an adaptation of Deming's concept of process improvement (plan–do–check–act) and on Philip Crosby's quality management maturity grid, which "describes five evolutionary stages in adopting quality practices" (Crosby, 1979). The underlying premise of process maturity modelling is that the quality of a product is directly related to the quality of the process used to develop that product (Paulk et al., 1995). Process maturity modelling is based on the assumption that to sustainably improve a process, there is an evolutionary path or set of thresholds through which the process must transition. This evolutionary path is referred to as the process maturity framework and consists of various stages of progression, which, when adhered to, increases the effectiveness of a process in achieving its objectives. Researchers at the Software Engineering Institute at Carnegie Mellon University used this concept in the development of the Capability Maturity Model or CMM (Paulk et al., 1995). The CMM, which is based directly on the original framework and the concept of process maturity, best highlights the thresholds of maturity through which a process must transition to be sustainably improved. These five thresholds of maturity are shown in Figure 1 and are collectively referred to as the five levels of process

maturity (Paulk et al., 1995). Initially, a process is chaotic or ad-hoc and must be made repeatable; then, it must be defined or standardised. The process must then be managed (i.e., measured and controlled). Ultimately, the process must be optimised, this is, it must be continuously improved via feedback and through the use of innovative ideas and technologies.

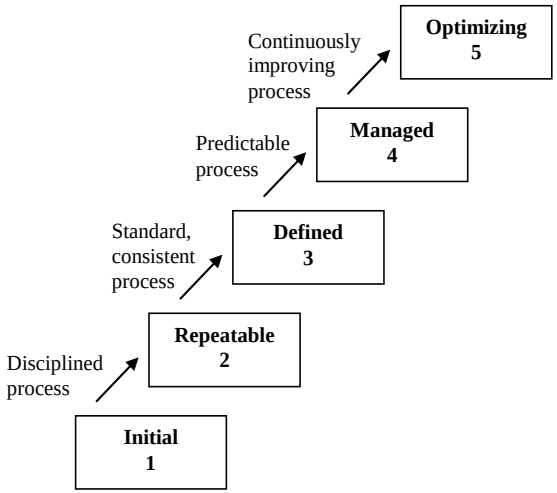

Figure 1. The five levels of process maturity
Source: Paulk et al., (1995).

The utility gained from process maturity modelling has been investigated by various researchers. In the field of software development, it was found that improved process maturity had the net effect of reducing the overall software development cycle as well as reducing the development effort (Harter et al., 2000), whereas in the field of project management, Ibbs and Kwak (2000) found that higher levels of project management maturity resulted in improved project performance.

The above concept of process maturity has since been applied in the construction industry in the form of micro- or organisational level maturity models, such as the Standardised Process Improvement for Construction Enterprises (SPICE) (Sarshar et al., 1999; Amaratunga et al., 2002) and the Construction Supply Chain Maturity Model (CSCMM) (Vaidyanathan and Howel, 2007). In the area of project management, the process maturity concept has been applied in a myriad of project management maturity models, of which the Organisational Project Management Maturity Model (OPM3) (PMI, 2005) is one of the most notable. At the macro-level of the construction industry, the concept of process maturity has yet to be applied. Currently, only one such model exists and is referred to as the Fuzzy Industry Maturity Grid (FIMG) (Tay and Low,1994).

OVERVIEW OF THE CIM3

The CIM3 is based on an adaptation of the concept of process improvement exemplified in the process maturity framework first developed and used by Watts Humphrey in the CMM. The goals of the CIM3 are as follows: model the maturity of the construction industry at the macro level to provide leading indicators of project performance, provide a context in which to interpret project performance, enable comparisons between various countries and regions and provide guidance with respect to construction industry performance improvement initiatives. Based on the above goals, the CIM3 views the construction industry as being structured as shown in Figure 2, where the construction industry is viewed as being composed of Key Practice Areas (KPAs), which contain key practices. Simply put, a key practice is an approach or way in which the construction industry seeks to achieve a specific objective. It is a description of an activity or set of activities, regulations and infrastructure that are relied upon to achieve various objectives. Each key practice is assessed to determine the industry's capability with respect to that key practice and the capability is transformed into a level of maturity. There are three possible levels of maturity associated with each key practice and the determination of each level of maturity is based on the presence of specific outcomes and/or indicators. The outcomes/indicators are the tangible or intangible results of the industry's current capability concerning a key practice.

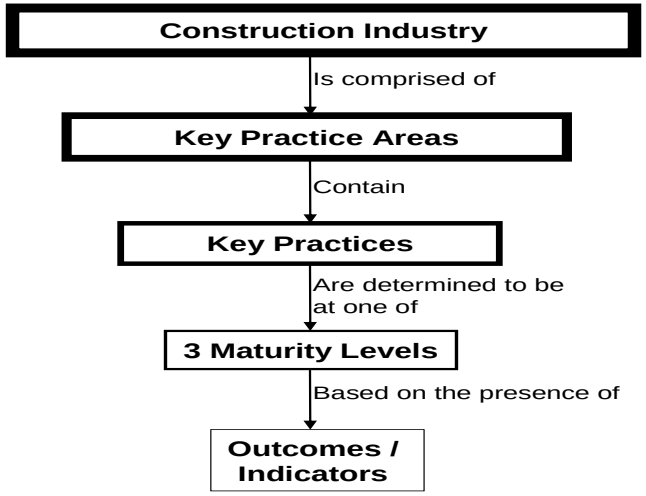

Figure 2. General structure of the CIM3
Source: Willis and Rankin, (2009).

Each KPA has a performance goal and the key practices within a KPA collectively reflect the way in which the construction industry seeks to achieve the performance goal of the KPA. Figure 3 shows the underlying logic of the CIM3 concerning a key practice

and the performance of the construction industry. The maturity of the construction industry with respect to its key practices informs us of how effective and efficient the construction industry is in achieving specific objectives, which, in turn, influence the realisation of the construction industry's overall performance goals.

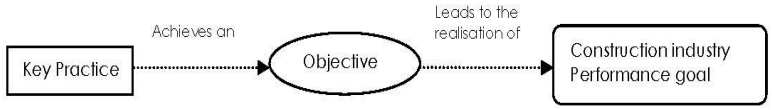

Figure 3. Underlying logic of a key practice and the performance of the construction industry

Source: Willis and Rankin, (2009).

It is important to note that, at the macro level, the maturity assessment focuses on the capability of the construction industry with respect to its key practices, i.e., the capacity or ability of the construction industry to extensively use and consistently implement a key practice and to improve the effectiveness of the key practice. In contrast, at the micro level, an assessment of maturity is likely to focus on the consistency with which key processes are implemented as is reflected in micro-level maturity models, such as SPICE, CSCMM and OPM3. This is a subtle yet noteworthy departure from the original concept of process maturity, with the underlying reason being that the characteristics of the construction industry, i.e., the uniqueness of construction products as well as the dynamic and unique circumstances under which construction projects are executed, do not make assessing processes at the macro level feasible. This is because most processes will be inconsistent between different construction organisations and between different types of construction projects. At the macro level, it is more feasible to analyse the construction industry according to key practices because these are supposed to be inherent in all construction organisations and on all types of construction projects, although the sequence of their concomitant activities, regulations, infrastructure and sub-processes will be different between organisations and various types of projects.

The three levels of maturity of the CIM3 are shown in Figure 4, in which each level is assigned a numeric score referred to as the capability score. The 'immature' level is assigned a capability score of 1/3, the 'transitional mature' level is assigned a capability score of 2/3 and the 'mature' level is assigned a capability score of 1. The capability score demonstrates the construction industry's current capability in implementing a key practice and informs us of the location of the key practice within the maturity framework. It provides an indication of the potential for the construction industry to grow or improve its capacity with respect to the use of the key practice. The score of 1/3 indicates that the construction industry is at 1/3 of its full

capacity with respect to the use of a 'key practice', 2/3 indicates that the construction industry is at 2/3 of its full capacity with respect to its use of a key practice and 3/3 indicates that the construction industry is at its full capacity or growth with respect to its use of a key practice.

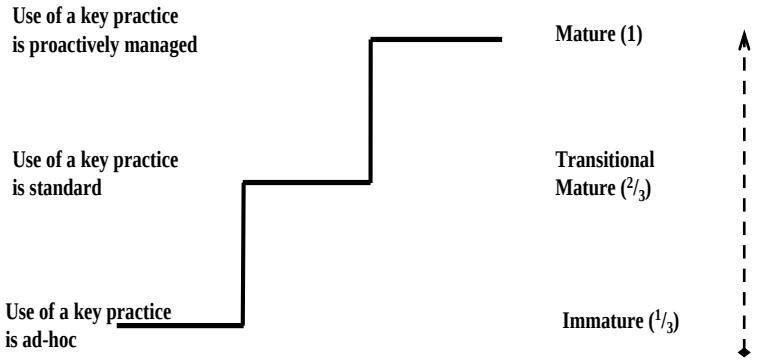

Figure 4. The three levels of maturity used in the CIM3
Source: Willis, (2010).

IMPLEMENTATION OF THE CIM3 IN GUYANA

In assessing the maturity of Guyana's construction industry, the CIM3 was implemented using input collected by surveying a group of experts. The size and characteristics of the group of experts that was consulted was of the utmost importance as it directly affected the reliability and accuracy of the resulting maturity assessment. Table 1 is a summary of the main attributes of the members of the Guyana construction industry expert group. The expert group consisted of eight local civil engineers with experience ranging from 7 to 28 years, a cumulative tenure of 102 years and an average experience of 12.75 years. The employment positions of the members of the expert group included project coordinators, project managers, project engineers and a director. The sectors of current employment of the eight local experts within the construction industry included consultancies, contracting firms and client organisations. This combination of experts was critical because it influenced the type of knowledge and experience that was elicited from the group and ensured that biases were cancelled out when the eight experts were ultimately considered as a single unit.

Table 1. Summary of the traits of the members of the expert group

Expert #	Level of Education	Experience (Years)	Employment Position	Sector of Employment
1	B.Eng.	16	Project Manager	Contracting
2	Post Grad. Diploma	7	Project Engineer	Consultancy
3	B.Eng.	7	Project Engineer	Consultancy
4	M.Sc.	20	Project Manager	Consultancy
5	B.Eng.	9	Project Engineer	Consultancy
6	M.Sc.	28	Project Coordinator	Client Organisation (Public)
7	B.Eng.	8	Director	Contracting
8	M.Sc.	7	Senior Engineer	Client Organisation (Public)

Source: Willis, (2010).

It is important to note that the pool from which the eight experts were selected from was very small due to Guyana's high rate of migration of skilled professionals (International Monetary Fund, 1999), especially civil engineers who are leaving to work in various Caribbean territories. In fact, there are no more than 20 engineers registered with the Guyana Association of Professional Engineers (GAPE, 2008). Initially, contact was made with 12 experts, of which eight agreed to participate in the study.

Figure 5 depicts the general implementation framework utilised by the CIM3 in Guyana. The framework consisted of two parts. The first part sought to establish weights of importance of the key practices (i.e., at level three of the maturity hierarchy) and of KPAs (i.e., at level two of the maturity hierarchy). The second part of the framework sought to establish the construction industry's capabilities with respect to each of its key practices. The implementation of the first part commenced with each member of the expert group carrying out AHP pair-wise comparisons of the key practices and KPAs and concluded with the aggregation of the resulting AHP pair-wise judgments to produce a single set of weights of importance for each of the key practices and KPAs. The implementation of the second part commenced with administering a questionnaire survey to each member of the expert group, which was followed by aggregating the questionnaire responses to determine the consensus of the expert group. It is important to note that the questionnaire survey was administered in an interview session after the experts were finished with the AHP pair-wise comparisons. As an example, a copy of the quality management questionnaire survey is provided in Appendix 1. The second part concluded with a random verification of the questionnaire responses. Collectively, both parts of the implementation framework led to the development of numeric scores of maturity, which were used as leading indicators of performance and provided a context in

which to interpret and compare the construction industry's performance.

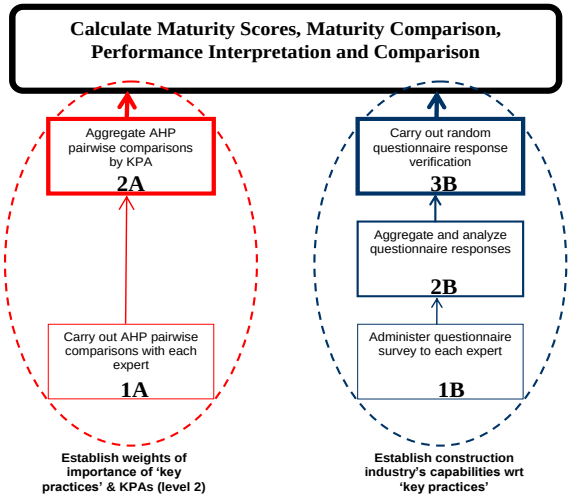

Figure 5. General implementation framework of the CIM3 in Guyana

Source: Willis, (2010).

In assessing the maturity of Guyana's construction industry, the KPAs and key practices that were focused on included cost management, quality management, health and safety management and human resource management. These KPAs, along with their key practices, are listed in Appendix 2, which provides brief descriptions of the management objectives and performance goals of each key practice. After the weights of importance and capabilities of the construction industry in implementing the key practices were determined using the procedure described above, numeric scores of maturity were calculated as a means of transforming the subjective concept of maturity into a set of objective measures that could be compared and interpreted as forward-looking indicators of performance.

NUMERIC SCORES OF MATURITY

Maturity scores were derived at three hierarchical levels, as shown in Figure 6. At level 3, a maturity score for each key practice is calculated; whereas at level 2, a maturity score for each KPA is calculated. Ultimately, at level 1, a single maturity score is calculated for the entire construction industry.

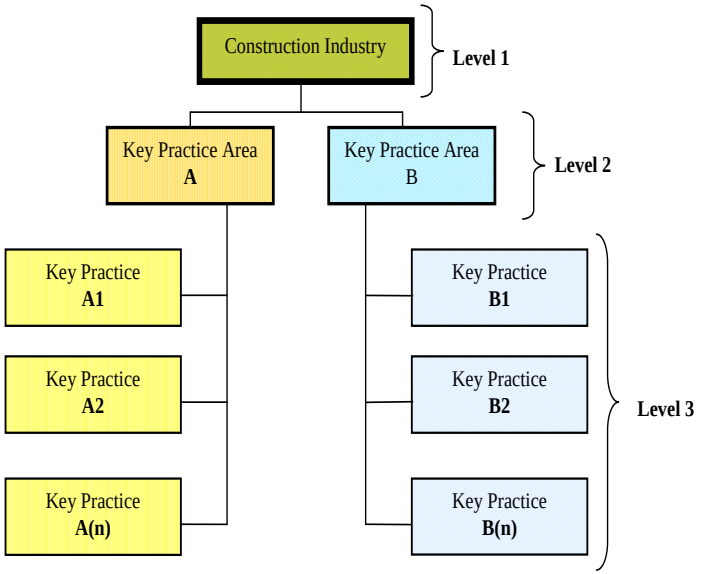

Figure 6. Hierarchical structure of the CIM3 showing the three levels of maturity scores

Source: Willis, (2010).

The calculation of the maturity scores at each of the three hierarchical levels utilised the outputs of the two parts associated with implementing the CIM3, i.e., the weights of importance and the capabilities of the construction industry represented as capability scores. The calculation of the maturity scores is summarised in the following expressions:

At level one: $MS_{Construction\ Industry} = \Sigma\ MS_{KPA}$ Eq.1

At level two: $MS_{KPA} = \Sigma\ (MS_{Key\ Practice})\ X\ AHP_{KPA}$ Eq. 2

At level three: $MS_{Key\ Practice} = CS_{Key\ Practice}\ X\ AHP_{Key\ Practice}$ Eq. 3

where:

MS_{KPA} is the maturity score of a KPA,
$MS_{Key\ Practice}$ is the maturity score of a key practice,
$MS_{Construction\ Industry}$ is the total maturity score of the construction industry,
AHP_{KPA} is the weight of importance of a KPA derived via the analytic hierarchy process,
$AHP_{Key\ Practice}$ is the weight of importance of a key practice to the performance goal of its KPA derived via the analytic hierarchy process and
$CS_{Key\ Practice}$ is the capability score of a key practice.

RESULTS – MATURITY AT LEVEL 3

The maturity of Guyana's construction industry at level 3 of the CIM3's maturity framework is based on the relative importance of a key practice to the performance goal of its KPA determined using AHP pair-wise comparisons and

the capabilities of the industry in implementing the key practices. The numeric values of maturity of the key practices are shown by bar charts in Figures 7 to 10, where the shaded portion of each bar represents the calculated maturity scores of a key practice and the un-shaded portion represents the possible potential growth of a key practice. The entire length of a bar is an indication of the maximum possible level of influence of a key practice on the performance goal of its KPA. The maturity scores inform us of two things. First, when compared with each other, the magnitude of the maturity scores (shaded portion of each bar) informs us of the existing levels of influence of the key practices on the performance goal of the KPA. Second, the maturity scores of each key practice, when compared to its maximum possible potential growth, inform us of the extent to which the objectives associated with each of the key practices are being achieved.

Figure 7 compares the maturity scores of the cost management key practices and shows that the key practices CM1, CM3 and CM4 have achieved full maturity and therefore have zero potential growth. On the other hand, the key practices CM2, CM8 and CM9 are currently immature and therefore have the greatest potential growth. The key practices CM5, CM6 and CM7 are currently in a transitional state of maturity and therefore also have some potential for further growth. In terms of the realisation of the objectives of the key practices, the objectives associated with CM1, CM3 and CM4 have been fully realised, whereas the objectives associated with CM2, CM5, CM6, CM7, CM8 and CM9 have only been partially realised. The level of influence of the key practices on the construction industry's cost performance goal is lowest for CM3 and greatest for CM7.

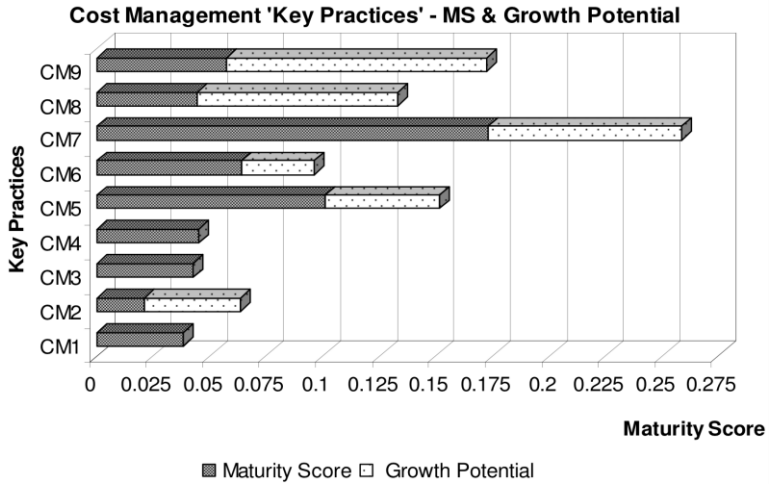

Figure 7. Comparison of the maturity scores and growth potential of cost management key practices

Source: Willis, (2010).

When considered as leading indicators of cost performance, it appears that the key practices CM7, CM9, CM5 and CM8 are the most significant, whereas CM4, CM3 and CM2 are the least significant. Interventions aimed at improving the construction industry's cost performance should, therefore, first focus on improving the maturity of the four former key practices because these are likely to bring about more noticeable changes in the industry's cost performance.

Figure 8 compares the maturity scores of the quality management key practices. For these key practices, it was found that none of them have attained full maturity, whereas the key practices QM1, QM2, QM3 and QM7 are immature and QM4, QM5, QM6 and QM8 are transitional mature. As such, the objectives associated with each of them are only partially being realised. This means that the quality performance goal of Guyana's construction industry is not being fully achieved. The key practices with the greatest influence on the achievement of the construction industry's quality performance goal are QM6, QM4, QM7 and QM8, with QM6 having the greatest level of influence. The key practices with the lowest levels of influence on the achievement of the construction industry's quality performance goal are QM3, QM1, QM5 and QM2, with QM3 having the least influence.

As leading indicators of construction industry quality performance, it appears that the key practices QM6, QM4, QM7 and QM8 are the most significant. Therefore, interventions aimed at improving the construction industry's quality performance should first focus on improving the maturity of these key practices because an increase in their maturities is likely to have a more noticeable impact on the industry's lagging quality performance.

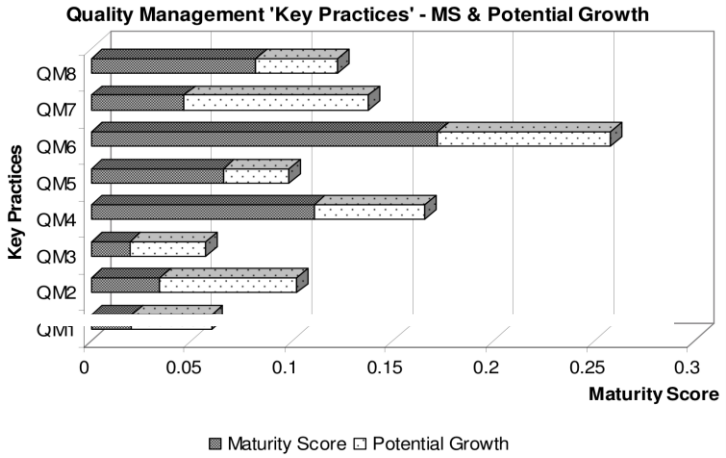

Figure 8. Comparison of the maturity scores and potential growth of the quality management key practices

Source: Willis, (2010).

Figure 9 compares the maturity scores of the health and safety management key practices. The bar chart shows that the construction industry is immature with respect to each of these key practices, meaning that the realisation of the construction industry's health and safety management objectives are being significantly underachieved. This implies that the construction industry's health and safety management performance goal is being significantly underachieved. Of the 13 health and safety management key practices that were assessed, the 5 with the greatest influence in achieving the health and safety performance goal are HS13, HS11, HS9, HS12, HS7 and HS6,

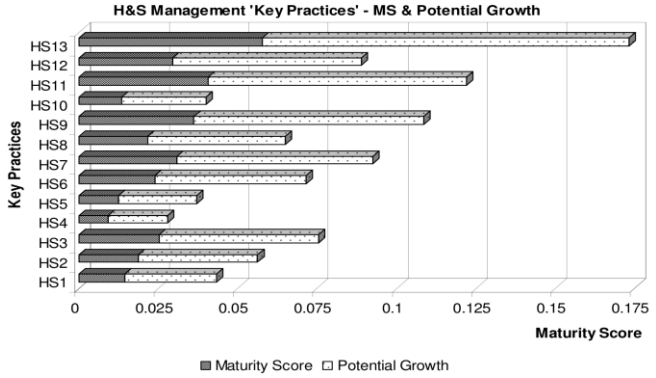

Figure 9. Comparison of the maturity scores and potential growth of the health and safety management key practices

Source: Willis, (2010).

with HS13 having the greatest level of influence. The five key practices with the least influence on the construction industry's health and safety performance goal are HS4, HS5, HS10, HS1 and HS2, with HS4 having the lowest level of influence.

As leading indicators of the construction industry's health and safety management performance, it appears that HS13, HS11, HS9, HS7 and HS12 are the most significant and should, therefore, be the main focus of improvement interventions. It is likely that improvements in the maturities of these key practices will result in significant positive changes in the construction industry's lagging health and safety performance.

Figure 10 compares the maturity scores of the human resource management key practices. It was found that the construction industry is immature with respect to nine of these key practices, these being HR2, HR3, HR4, HR5, HR6, HR7, HR8, HR10 and HR12. The construction industry was found to be in a transitional state of maturity with respect to key practices HR9 and HR11 and fully mature with respect to key practices HR1 and HR13. This means that key practices HR1 and HR13 have reached their full growth; therefore, their objectives are being fully achieved. On the other hand, the remaining 11 key practices each have the potential to grow; therefore, their objectives are only partially being achieved. The overall human resource

management performance goal of the construction industry is therefore not being fully realised. Of the 13 HR management key practices that were assessed, the 5 with the greatest level of influence on the HR performance goal are HR4, HR2, HR6, HR11 and HR10, with HR4 having the greatest influence on the performance goal. On the other hand, the five key practices with the lowest level of influence are HR1, HR13, HR8, HR5 and HR3, with HR1 having the least influence on the performance goal.

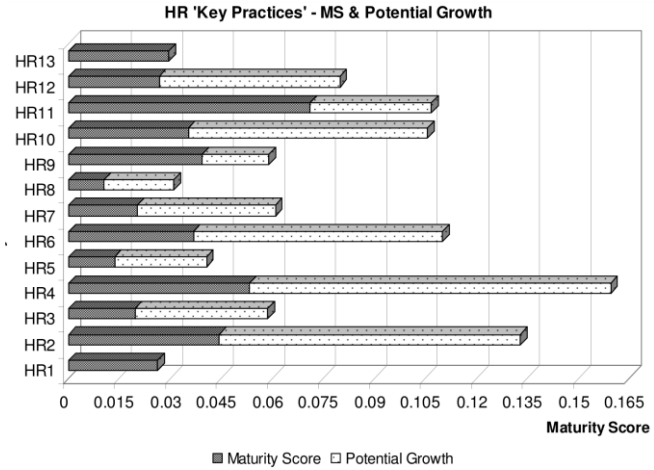

Figure 10. Comparison of maturity scores and potential growth of human resource management key practices

Source: Willis, (2010).

As leading indicators of the construction industry's human resource management performance, it appears that the key practices HR4, HR2, HR6, HR11 and HR10 are the most significant. These key practices should, therefore, be the main focus of improvement interventions because increases in their maturity are likely to result in improvement in the construction industry's human resource management performance.

Table 2 summarises the results presented in the preceding figures to accommodate a more general comparison and discussion. The table lists the four KPAs along with the summation of the maturity scores of their key practices. The summation of the maturity scores allows us to determine which KPA is the most mature and which is the least. The results can be used to further highlight the extent to which the performance goals of the KPAs are being achieved and therefore give an idea of the likely overall lagging performance of the construction industry that can be expected with respect to each of the KPAs. Of the four KPAs, the cost management key practices have the greatest maturity, followed by the quality management key practices and then the human resource management key practices and the health and safety management key practices. This is translated as meaning that the construction industry's cost performance goal is being realised to a greater extent than the quality, human resource and health and safety performance goals. At

present, the construction industry's health and safety management performance goal is the least realised.

Table 2. Values of the ∑ (MS Key Practice)

KPA	Σ (MS Key Practice)
Cost	0.5857
Quality	0.5481
HR	0.4256
H&S	0.3333

Source: Willis, (2010).

RESULTS – MATURITY AT LEVEL TWO

Table 3 presents the maturity scores of Guyana's construction industry at level two (i.e., MS KPA). In addition, the table shows the maximum possible maturity score for each of the KPAs and their potential growth represented as a percentage. The MS KPA indicates the level of contribution of a KPA to the overall maturity of the construction industry. For Guyana's construction industry, the quality management KPA has the greatest contribution to the overall maturity of the construction industry with a score of 0.2384, followed by the cost management KPA (0.2201) and then the human resource management KPA (0.0433) and lastly the health and safety management KPA (0.0343). This implies that based on the perception of those within Guyana's construction industry, the current overall or general performance of Guyana's construction industry is affected to a greater extent by the maturity of its quality management and cost management key practices and to a lesser extent by the maturity of its human resource management and health and safety management key practices. In terms of the potential growth of the maturity of each of the four KPAs, the health and safety management KPA has the greatest potential growth at 66.73%, followed by the human resource management KPA (55.36%), then by the quality management KPA (45.23%) and, finally, the cost management KPA (39.63%). These scores further reinforce the hypothesis that the operation of Guyana's construction industry is likely to be most advanced in cost management and least advanced in health and safety management.

Table 3. MS KPA for Guyana's construction industry

KPAs	MS KPA : ∑ (MS Key Practice) X AHP KPA	Maximum Possible MS KPA	Potential Growth
Cost Management	0.2201	0.3646	39.63%
Quality Management	0.2384	0.4353	45.23%
Human Resource Management	0.0433	0.0970	55.36%
Health and Safety Management	0.0343	0.1031	66.73%

Source: Willis, (2010).

Based on the above discussion, any attempt to improve the overall performance of Guyana's construction industry should first focus on improving the maturity of its cost management and quality management key practices. Although these two KPAs are currently more advanced in maturity in comparison to the human resource management and health and safety management KPAs, as reflected in their potential growth, their maximum possible contribution to the overall maturity of the construction industry and thus its performance, is far greater than the combined contribution of the human resource management and health and safety management KPAs. While improving the maturity of the human resource management and health and safety management KPAs will improve the overall performance of the construction industry, the improvement in performance is likely to be perceived by those within the construction industry as being inadequate and ineffective within a larger context.

RESULTS – MATURITY SCORES AT LEVEL ONE

The level one maturity score (i.e., $MS_{Construction\ Industry)}$ is a single maturity score representing the overall maturity of the construction industry. The $MS_{\ Construction\ Industry}$ of Guyana's construction industry is calculated as being 0.5361, or 53.61%. This means that Guyana's construction industry is currently 53.61% mature and therefore has an overall growth potential of 46.39%. In general, Guyana's construction industry is currently immature and its propinquity in terms of entering the transitional maturity level is still far off. This immaturity is shown in Figure 11, which highlights the relationship between the current maturity of Guyana's construction industry and the realisation of its combined performance goals. At present, the realisation of the combined performance goals of Guyana's construction industry is being significantly underachieved. Interpreted as a leading indicator of performance, this means that the measured lagging performance of Guyana's construction industry is likely to be relatively poor with significant potential for improvement.

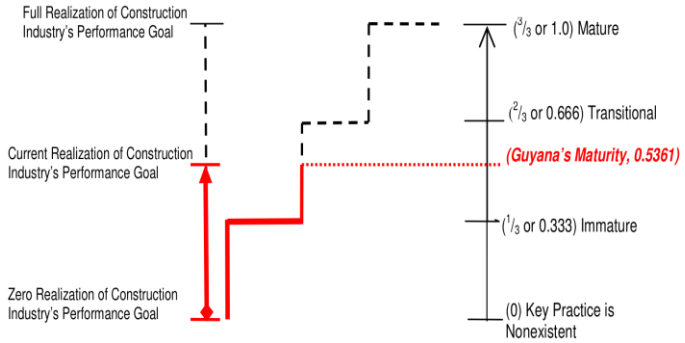

Figure 11. Relationship between the maturity of Guyana's construction industry and its combined performance goals

Source: Willis, (2010).

The first step towards improvement should be to improve the maturity of specific KPAs to enable the construction industry to enter into the transitional phase of maturity. It appears that the KPAs of cost management and quality management are best suited for this purpose. Once this is done, focus can be placed on improving the maturity of the lesser KPAs of human resource management and health and safety management, which will serve to move the construction industry closer to full maturity and the full realisation of its performance goals. In essence, this approach seeks to improve cost and quality performances first, as these are perceived by those within Guyana's construction industry as being the most critical of the four KPAs. By using this approach, there will be a greater recognition and acceptance of the improvement initiatives by those within the construction industry, which will greatly increase the chances of performance improvement initiatives being successfully implemented.

CONCLUSION

This paper has discussed aspects of the newly developed maturity model CIM3 and its implementation in Guyana. With respect to the maturity of Guyana's construction industry, the CIM3's assessment found the following:

(1) Guyana's construction industry is currently immature, with its cost management key practices being more mature than those of quality management, human resource management and health and safety management. Based on this finding, the construction industry's cost management objectives are being achieved to a greater extent than those of the other key practices. This has led to the cost management performance goal having the highest level of realisation relative to the other performance goals of the construction industry.

(2) In translating the overall maturity of Guyana's construction industry, it was found that the overall level of realisation of the combined performance goals of the

construction industry is significantly low. This translation is useful because it allows for the interpretation of the lagging performance measures of the construction industry. Based on the findings of the CIM3, it is predicted that the lagging performance measures of Guyana's construction industry will be poor.

(3) The maximum possible maturity scores reveal that the overall performance of Guyana's construction industry is influenced to a greater extent by its quality management key practices, followed by its cost management key practices, then by its health and safety management key practices and, finally, by its human resource management key practices. As part of a roadmap to improving the performance of Guyana's construction industry, there may be a need to convince those within the industry of the importance of human resource management and its direct and indirect benefits concerning project and organisational performance. An assessment of the maturity of the construction industries of advanced countries, such as Canada, can be used to change the perceptions of those within Guyana's construction industry.

It is possible for the general maturity framework and method used in implementing this study to be applied to other developing countries, as the KPAs and key practices of the CIM3 are generic and are therefore likely to exist in most construction industries. Of interest would be the relative rank of importance of the KPAs and key practices between different developing countries.

In conclusion, the results of the maturity assessment provided by the CIM3 appear to be in line with the mainstream opinion concerning the current operation and level of advancement of Guyana's construction industry. At this point in time, future work concomitant with the CIM3 includes establishing direct and indirect relationships between the lagging performance of a country's construction industry and its maturity and linking the CIM3 with micro-level construction maturity models, such as those addressing construction organisation health and safety.

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APPENDIX 1: QUALITY MANAGEMENT QUESTIONNAIRE

Industry Practice QM1
There is a national building code, which is referred to in project design and construction as a means of ensuring acceptable levels of performance.

Assessment Questions
QM1-A: Is there a national building code, which is referred to in the design and construction of a majority of projects?

Yes ☐

No ☐

QM1-B: Are there revised versions of the national building code?

Yes ☐

No ☐

QM1-C: Does the national building code promote the use of innovative techniques and technological aids?
Yes ☐

No ☐

Industry Practice QM2
Construction organisations utilise Total Quality Management (TQM) as a means of ensuring and improving quality.

Assessment Questions
QM2-A: Is TQM utilised by a majority of construction organisations?

Yes ☐

No ☐

QM2-B: Do a majority of construction organisations utilise the latest techniques and approaches associated with TQM?

Yes ☐

No ☐

Industry Practice QM3
Construction organisations utilise ISO certification as a means of ensuring and improving quality.

Assessment Questions
QM3-A: Are a majority of construction organisations ISO certified?

Yes ☐

No ☐

QM3-B: Do a majority of construction organisations utilise the latest versions of ISO certification?

Yes ☐

No ☐

Industry Practice QM4
Quality specifications are used in construction contracts as a means of defining the required quality of various aspects of construction.

Assessment Questions
QM4-A: Are quality specifications for common aspects of construction consistent for a majority of projects?

Yes ☐

No ☐

QM4-B: For a majority of projects, are there up-to-date versions of quality specifications that promote the use of new techniques, materials and technological aids?

Yes ☐

No ☐

QM4-C: Is the effectiveness of quality specifications improved based on industry feedback and measures of project performance?

Yes ☐

No ☐

Industry Practice QM5
Weekly and monthly reports are used to report quality issues during the execution of construction projects.

Assessment Questions
QM5-A: Are weekly and monthly quality reports produced for a majority of construction projects?

No ☐

Yes ☐

QM5-B: Is the effectiveness of weekly and monthly quality reports improved through industry feedback?

Yes ☐

No ☐

Industry Practice QM6
Quality inspections are used on construction projects as a means of verifying and ensuring quality.

Assessment Questions
QM6-A: Are quality inspections done for a majority of construction projects?

Yes ☐

No ☐

QM6-B: For a majority of projects, do quality inspections utilise the latest techniques and technological aids?

Yes ☐

No ☐

QM6-C: Is the effectiveness of quality inspections improved through the use of industry feedback?

Yes ☐

No ☐

Industry Practice QM7
Quality management plans are used on construction projects as a means of ensuring quality.

Assessment Questions
QM7-A: Are quality management plans developed and used for a majority of construction projects?

Yes ☐

No ☐

QM7-B: For a majority of projects, do quality management plans refer to the use of the latest quality management techniques and technological aids?

Yes ☐

No ☐

QM7-C: Is the effectiveness of quality management plans improved via adjustments based on industry feedback?

Yes ☐

No ☐

Industry Practice QM8
Punch list inspections are performed as part of project closeout to highlight and rectify outstanding quality issues.
Assessment Questions

QM8-A: Are punch list inspections performed at project close out for a majority of projects?

Yes ☐

No ☐

QM8-B: For a majority of projects, are punch list inspections done using the latest techniques and technological aids?

Yes ☐

No ☐

APPENDIX 2: LIST OF KEY PRACTICES AND THEIR ASSOCIATED OBJECTIVES AND PERFORMANCE GOALS

Table A: List of cost management key practices and their associated objectives and performance goals

Cost Management Key Practices	**Objective**
CM1: The earnings of construction workers adhere to an industry-wide salary scale	Control and limit the salaries of project employees1
CM2: Cost indices are used in the development of construction cost estimates	Develop accurate and reliable construction cost estimates1
CM3: Consultancies charge hourly rates for various design and supervision services	To be adequately reimbursed for services rendered and to control and limit the cost of various consultancy services1
CM4: Equipment and labour rates are charged by contractors for various types of construction work	To be adequately reimbursed for construction services and to control and limit the cost of various construction services1
CM5: Construction costs are monitored and reported during the execution of projects	Inform project stakeholders of actual project costs during project execution1
CM6: Contractors submit progress payment claims during project execution	Recover project expenditures in a timely manner to pay for future project activities1
CM7: The client issues intermediate payments to contractors within a specified timeframe	Compensate the contractor for work completed in a timely manner to aid in the contractor in having a good cash flow1
CM8: Construction organisations use organisational performance measures as a means of monitoring and controlling their business operations	Ensure business operations are within budget and organisational cash flow is positive1
CM9: Contractors develop formal cash flow schedules at the commencement of construction projects as a means of managing project costs	Forecast project expenditure and income so as to determine the availability of adequate financial resources1

Source: Willis, C.J. (2010)

[1] The performance goal of the cost management key practices is "to *deliver construction projects within budget*".

Table B: List of quality management key practices and their associated objectives and performance goals

Quality Management Key Practices	Objectives
QM1: There is a national building code that is referred to in project design and construction as a means of ensuring acceptable levels of performance	Ensure construction projects conform to certain required minimum standards2
QM2: Construction organisations utilise TQM as a means of ensuring and improving quality	Ensure there is a desired level of quality in the construction process and in the construction product2
QM3: Construction organisations utilise ISO certification as a means of ensuring and improving quality	Ensure there is a desired level of quality in the construction process and in the construction product2
QM4: Quality specifications are used in construction contracts as a means of defining the required quality of various aspects of construction	Provide a comprehensive description of the desired attributes and quality of the construction process and the constructed product2
QM5: Weekly and monthly reports are used to report quality issues during the execution of construction projects	Inform project stakeholders of quality issues as they arise during the execution of construction projects2
QM6: Quality inspections are used on construction projects as a means of verifying and ensuring quality	Verify and ensure that the required levels of quality are being achieved2
QM7: Quality management plans are used on construction projects as a means of ensuring quality	Outline to project stakeholders, the approaches that will be taken to ensure that desired levels of quality will be achieved2
QM8: Punch list inspections are performed as part of project closeout to highlight and rectify outstanding quality issues	Highlight outstanding quality issues that need to be rectified before final completion2

Source: Willis, C.J. (2010)

[2] The performance goal of the quality management key practices is "to deliver construction projects at the desired quality".

Table C: List of HR Management Key Practices and their associated Objectives and Performance Goals

HR Management Key Practices	**Objectives**
HR1 Construction projects have established employment positions	Formalise the employment of construction industry workers3
HR2 Skill utilisation is assessed on construction projects so as to ensure that the correct types of project personnel are being assigned to various tasks/activities	Make sure that the correct types of project personnel are being assigned to various tasks/ activities3
HR3 The composition of work crews is planned for construction projects to ensure an appropriate ratio of workers to supervision for various project activities	Make sure there is an appropriate ratio of workers to supervision for various project activities3
HR4 Employees are subjected to various types of skill assessments and evaluations in advance of the execution of construction projects	Determine the abilities of workers in advance of the execution of construction projects3
HR5 The composition of work crews is tracked throughout the execution of construction projects to ensure an appropriate ratio of workers to supervision for various project activities	Verify and monitor the effectiveness with which workers are being supervised for various project activities3
HR6 Employees are subjected to various types of skill assessments and evaluations during the execution of construction projects	Determine the growth or improvement in employees' skills during project execution3
HR7 Project personnel receive on the job training on construction projects	Enhance/improve the skills of project personnel3
HR8 Incentives are used as a means of motivating project personnel during the execution of construction projects	Motivate project personnel during project execution3
HR9 There is a communication and information flow between project personnel during the execution of construction projects	Ensure the efficient flow of ideas and opinions during project execution3

(Continued on next page)

Table C: *(continued)*

HR Management Key Practices	Objectives
HR10 The construction industry has licensing requirements that are applicable to professionals seeking to work within the industry	Ensure and validate the education and training of professionals seeking to work within the industry3
HR11 Construction job vacancies have specific qualification and experience requirements	Ensure that qualification and experience requirements for specific jobs are consistent throughout the industry3
HR12 The construction industry has a strategic human resource plan that is consulted as a means of guiding its industry level HR related actions and decisions	Effectively guide the construction industry's HR related decisions and actions3
HR13 Positions of employment within construction organisations and on construction projects have associated with them specific levels of remuneration and benefits	Ensure levels of remuneration and benefits are consistent for employment positions 3

Source: Willis, C.J. (2010)

[3] The performance goal of human resource management key practices is "to ensure the efficient use of the industry's human resources".

Table D: List of H&S Management Key Practices and their associated Objectives and Performance Goals

H&S Management Key Practices	**Objectives**
HS1: There are national H&S laws and regulations that are applicable to various types of construction work	Make mandatory, safe construction working conditions and practices4
HS2: The construction industry has H&S training programs that are used to train construction workers regarding safe working practices	Continuously train construction workers in safe working techniques4
HS3: Construction organisations have a formal H&S policy that guides their approach to the H&S of their workers	Clearly state and make known the overall intention and objectives with respect to health and safety4
HS4: General contractors screen subcontractors for their H&S programs and choose those with records of good performance	Increase the likelihood of employing only subcontractors with good records of safety performance4
HS5: Construction organisations implement drug and alcohol testing of their employees as part of their H&S program	Ensure employees can work in a safe manner and are not a danger to themselves or others4
HS6: H&S management plans are utilised on construction projects to ensure the H&S of project personnel	Outline to project stakeholders, the approaches that will be taken to address safety issues during the execution of construction projects4
HS7: Money is budgeted on construction projects in to address various H&S issues	Ensure there are financial resources to address H&S issues during the execution of construction projects4
HS8: Hazard analysis is used to identify hazards on construction projects	Identify hazards on construction projects to eliminate or mitigate them during the execution of construction projects4

(Continued on next page)

Table D: (continued)

H&S Management Key Practices	Objectives
HS9: Construction projects have safety induction programs	Introduce new project personnel to relevant safety techniques and practices to be used on the project4
HS10: The performance of contracting firms regarding H&S is considered when awarding contracts	Increase the likelihood of awarding contracts to only contracting firms with good H&S performance4
HS11: Construction organisations provide their employees with safety equipment	Ensure construction workers have the relevant protective/safety equipment 4
HS12: Toolbox meetings are held regularly during the execution of construction projects as a means of raising the H&S awareness of project personnel	Raise the awareness of project personnel regarding various H&S issues and concerns4
HS13: Construction organisations adhere to a national construction H&S code of practice as a means of improving their H&S performance	Have a formal approach to H&S 4

KPAs	MS KPA : Σ (MS Key Practice) X AHP KPA	Maximum Possible MS KPA	Potential Growth
Cost Management	0.2201	0.3646	39.63%
Quality Management	0.2384	0.4353	45.23%
Human Resource Management	0.0433	0.0970	55.36%
Health and Safety Management	0.0343	0.1031	66.73%

Source: Willis, C.J. (2010)

[4] The performance goal of H&S management practices is "to execute construction projects in a safe manner and reduce the number of accidents".