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Quantification Model for Applying Construction Management Practices in Consideration of Project Characteristic Factors

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Abstract: No single project is identical to one another in the construction industry. Furthermore, many construction projects are suffering from tighter budget, shortened schedule and higher client satisfaction level. To overcome these, project managers and engineers are willing to apply various best management practices to their projects. However, it is non-trivial to select the most appropriate practices for their projects. In many cases, it is much more important to find the appropriateness of the management practices than just to use the practices. Although many researchers are focusing on the development of new management practices, there is little research on matching between the circumstances of projects and the developed management practices. The objective of this study is to provide a structured process to suggest the best management practices for individual construction projects by developing a computerized system where an individual project is matched with the most optimal management practices to increase the value of the project. At this stage of writing, the authors have developed a computerized system to effectively find out the best suitable management practices for individual projects. By maximizing the usages of this system, it would facilitate the application of the best management practices in the industry.

Keywords: Construction Management Practice, Quantitative Model, Project Performance, Web-based System

I. INTRODUCTION

In the construction industry, it is non-trivial to quantitatively measure the performance level of a project. The benchmarking metric system which has been developed by Construction Industry Institute (CII) is a good example for the performance quantification. Another example is the Key Performance Indicator (KPI) system originated by British government. However, many project stakeholders are concerned about their own projects, not the whole range of the other projects.

Any individual project has unique characteristic factors, i.e., technical or site condition, project participants, social/environmental system, etc. Many project performance measurement systems, however, have applied the single-dimensional analysis method which focuses on the comparison of simple performance measurement and/or the relationship between the best practices and the resulting levels of project performance. A unique construction project has a variety of project characteristics including both the predicable (inner-side) competence and the unpredictable (out-side) environmental impact. In order to effectively measure the performance level of a project, it is necessary to analyze the project by using a more multi-dimensional approach, which covers the whole range of dynamic project characteristics.

The purpose of this study is to build a system that can improve the most vulnerable performance area(s) by quantifying the potential performance areas and matching the best management practice. As a pioneering study, this research is still on-going in identifying the inter-relationship among the various factors. The output of this study, Project Performance Management System (PPMS) will be effectively used in the near future in capturing the significant findings by statistically analyzing the relationship among the factors, i.e. the project characteristics, performance areas, and management practices.

The process of this research is briefly provided in the following research methodology section. In the data collection section, the quantification strategy for the project data, including the performance, characteristics, and management practice is addressed. The PPMS system section describes how the web-based computer program is designed and operated to gather the project data to enhance the statistical significance. In the final section, the summary and concluding remarks are provided.

II. RESEARCH METHODOLOGY

The first step of this research is to review previous

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research work which has identified seven project performance areas (contract, cost, schedule, quality, risk, safety/environment, and productivity) (Kim et al. 2011). The quantification methodology has been developed in order to gather real case project performance data. Secondly, the conversion algorithm has been applied in order to modify the level of project performance data by incorporating the unique project circumstances. Each project has different project characteristics which affect the level of project performance. In this study, the authors use a difficulty index to convert the potential project performance level in consideration of project characteristics (Cho et al. 2011). Thirdly, the best construction management practices have been collected. In total, 15 practices have been selected as potential boosters which affect the performance level of a project. (see table 1) In the fourth step, the relationship among the management practices, project characteristics and performance areas has been analyzed with a hypothesis that there exists the best management practice(s) for a selected project when a project manager should want to improve the designated performance level. In the following final step, a computerized system has been developed by enhancing the data collection process in the future for the purpose of validating the statistically significance of the proposed project performance measurement algorithm.

TABLE I
OVERVIEW OF PROJECT PERFORMANCE DATA COLLECTION

Area	Contents	Unit
Performance Area	Contract, Cost, Schedule, Quality, Risk, Safety/Environment, Productivity	0-100 Scale
Project Characteristics	In-general (Project Type, Project Scale, Delivery Method, Site Condition), Project Participants (Owner, A/E, Contractor), Systems and Regulations (Legal, Economic, Social)	3 Point (High, Med, Low)
Construction Management Practice	Objective Setting, Partnering, Team Building, Benchmarking, VE, Execution Plan, Risk Mgmt, Incentives, Change Mgmt, Quality Mgmt, Time-Cost control, Material Mgmt, Subcontractor Mgmt, Information System, Innovative Technology	0-5 Scale

III. DATA COLLECTION & ANALYSIS

From the previous research work, the total of 27 real-case project data has been collected. (Go et al. 2011). To quantitatively measure the project performance data, each of the seven performance areas has been combined into a single numeric value by combining the individual mathematical equations which have been developed to evaluate the overall performance level. For example, to measure the contract performance, two sub-items are used. One is the average cost of dispute and the other one is the average time to resolve the disputes. Likewise, all the performance areas are quantified by applying this rubric-style numerical system. The combined performance area scores are analyzed to recognize whether the project circumstances affect the performance results. Table 2 shows the relationship between these two values. It is noteworthy that the project circumstances have been also converted into numerical values and the magnitude of scores indicate the level of difficulty in achieving the project performance.

TABLE I
DATA ANALYSIS: PROJECT CHARACTERISTICS VS. PERFORMANCE

Performance Area	Slope	Y-Intercept	Pearson's Coefficient
Contract	1.4416558	6.9528044	0.2566451
Cost	0.7008093	55.229982	0.1863679
Schedule	0.3028667	60.075556	0.0579464
Quality	-0.031151	78.741369	-0.009018
Risk	0.5509709	68.03036	0.1874204
Safety/Environment	-0.532516	89.282902	-0.268882
Productivity	1.3261892	-36.29468	0.3127772

As seen in table 2, some performance areas (contract and productivity) are highly affected by the project circumstances. This result indicates that the project characteristics should be considered in measuring the performance of a project. In other words, the project characteristics may distort the project performance, resulting in neglecting the implementation of the most suitable management practices for the subject project. The table 3 shows how the construction management practices are interlinked with the different types of project performance. As seen in this table, there also exists the strong difference in terms of relationship between the two variables.

TABLE III
OVERVIEW OF PROJECT PERFORMANCE DATA COLLECTION

Mgmt Practice	Contract	Cost	Schedule	Quality	Risk	Safety/ Envmt	Prdc tvty
Objective Setting	0.03	0.43	-0.06	-0.11	-0.21	-0.31	-0.03
Partnering	0.08	0.22	-0.17	0.22	-0.23	-0.02	-0.43
Teambuilding	-0.46	-0.41	0.32	0.46	-0.16	0.02	0.66
Benchmarking	-0.03	0.32	0.13	-0.26	0.41	-0.28	0.41
Value Engineering	0.01	0.55	-0.34	0.15	0.51	-0.33	0.17

As described above, the real-case projects are used in analyzing the project performance data. But, the data set (n=27) is too small to elicit any statistical significance. For example, in Table 3, even a negative relationship has occurred between best management practice and the project performance level. By quantifying the potential performance level and matching the most appropriate management practice, it is crucial to collect the data in a more rigorous way.

IV. DEVELOPMENT OF PROJECT PERFORMANCE MANAGEMENT SYSTEM (PPMS)

Figure I shows the conceptual model for developing project performance management system. This model is divided into two sub systems: One is data input (administration system) and the other one is data output (prediction system). In the input system, three types of project data, i.e., project characteristics, performance data, and management practices are input for the purpose of quantifying multi-dimensional project performance data.

The output system computes the level of project characteristics and calculates the potential project performance level in terms of seven performance areas. Using the target performance level, the higher-leveraged performance areas are elicited and the system finally recommends the most suitable management practice for the subject (new) project.

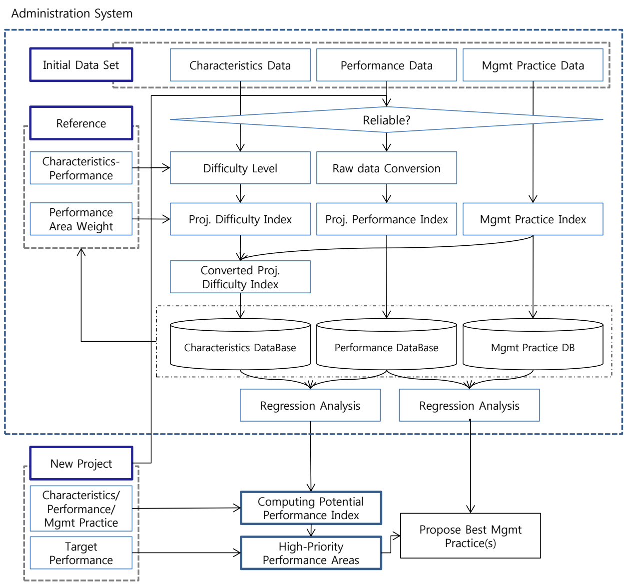

FIGURE I
CONCEPTUAL PROCESS MODEL OF PPMS

To secure the reliability of data set, the system is accessed by authorized personnel by inputting the user-ID and password. As seen in Figure II, the input data is also recognizable and modifiable for the administrator to correct the data when any type of errors occurs during the data-input stage.

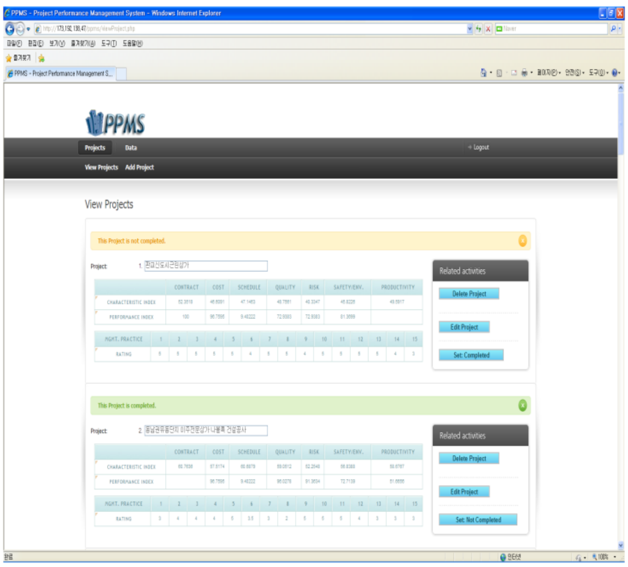

FIGURE II
DATA INPUT SYSTEM OF PPMS

The final output of PPMS is the recommendation of the best management practices for the "subject" project. By incorporating the embedded performance data, including the project characteristics and the usage level of project management practices, the potential project performance can be predicted in a quantitative format. By eliciting the inter-relationship between the management practices and the performance areas, the PPMS system suggests higher-potential management practices. Using this system, the user can evaluate and recognize the future performance level of the project in advance. In addition, the project stakeholders can be assisted in matching the suitable management practice for the new project.

As seen in Figure III, the PPMS recommends that the "productivity" is the worst performance area and "quality management" is the most suitable management practice to improve the project performance.

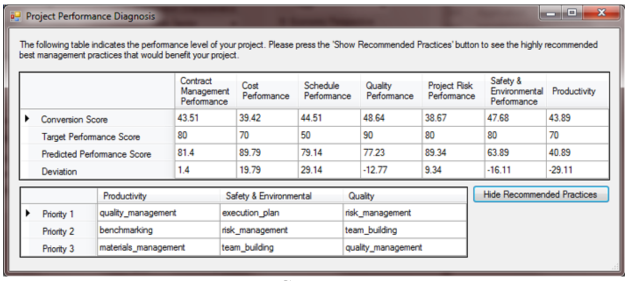

FIGURE III
RESULT SCREENSHOT OF PPMS

V. SUMMARY & CONCLUSIONS

In the arena of project performance measurement, many project practitioners are not quite sure of the effectiveness of implementing the best management practices because the project is more often than not dependent upon the outside project circumstances. By incorporating the project characteristics into the potential performance, they can reasonably select the most suitable management practice for individual projects. The finding of this study can be summarized as follows.

-There exists a strong relationship between the project performance areas and the project characteristics.
-The project performance can be affected not only by the project circumstances but also by management practices
-A certain area of project performance can be improved by implementing the most suitable management practices
-The proposed PPMS system can be a useful tool in evaluating the performance of a project and eliciting the best management practices

Although the proposed system is validated by real-case projects, a statistical significance has not been strongly achieved. A more rigorous data collection and analysis should be required to fully support the original research objectives.

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