INTEGRATION OF QUALITY MEASURES IN PROJECT CONTROL SYSTEM FOR CONSTRUCTION ORGANIZATIONS

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DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA

2004

INTEGRATION OF QUALITY MEASURES IN PROJECT CONTROL SYSTEM FOR CONSTRUCTION ORGANIZATIONS

By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

October 2004

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

INTEGRATION OF QUALITY MEASURES IN PROJECT CONTROL SYSTEM FOR CONSTRUCTION ORGANIZATIONS

By

ABDUL RAHMAN RAMAKRISHNA BIN ABDULLAH

October 2004

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Current project control system is not capable of initiating effective control actions to remedy performance shortfalls and overcome the occurrences of project overruns. The weakness in current system is that it does not evaluate quality performance together with schedule and cost performances of construction projects to initiate control actions. The research develops a method for deriving quality measure using material usage data and integrates the measure in current project control system to determine if project control is enhanced with the integration.

Current project control system integrated with quality measure is applied in several on-going construction projects and it is found to result significant improvement in the performance of the projects. The combined schedule, cost and quality performances in

projects initiated with control actions improved by 54%, 72% and 3% respectively. The organization's mean value for schedule, cost and quality performances also improved by 22%, 9.6% and 3% respectively and the standard deviation for schedule and quality performances reduced by 38% and 62% respectively. The deviation for cost performance however increased by 3% due to an abrupt leap in the cost performance of a single project, which was not subjected to control actions.

While performances in projects subjected to control actions improved significantly projects that were not subjected to similar control had schedule and cost performances deteriorated by 2.64% and 8% respectively. The substantial improvement achieved in projects subjected to control actions from using this upgraded control system validates the research hypothesis that integration of quality measure enhances its effectiveness in controlling project performance.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENGGABUNGAN UKURAN PENCAPAIAN KUALITI DALAM SISTEM KAWALAN PROJEK UNTUK ORGANISASI PEMBINAAN

Oleh

ABDUL RAHMAN RAMAKRISHNA BIN ABDULLAH

Oktober 2004

Pengerusi: Profesor Madya Ir. Md Yusof Ismail, PhD

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Sistem kawalan projek terkini tidak mampu menghasilkan tindakan-tindakan kawalan yang berkesan untuk memulihkan tahap pencapaian projek dan mengelak dari mengalami lebihan masa dan kos. Kelemahannya berpunca disebabkan tiadanya penilaian dilakukan terhadap tahap pencapaian kualiti bersama-sama dengan tahap pencapaian masa dan kos. Kajian ini mencadangkan satu kaedah untuk mengukur tahap pencapaian kualiti melalui data penggunaan bahan binaan dan kemudian menggabungkannya dalam sistem kawalan projek terkini bertujuan untuk memastikan samada keberkesanan sistem kawalan ini dapat dipertingkatkan melalui penggabungan tersebut.

Aplikasi sistem kawalan projek yang digabungkan dengan ukuran pencapaian kualiti terhadap beberapa projek pembinaan yang sedang dilaksanakan telah menghasilkan peningkatan tahap pencapaian yang nyata sekali. Tahap pencapaian terhadap masa, kos

dan kualiti di projek-projek yang tertakluk kepada tindakan kawalan telah meningkat sebanyak 54%, 72% dan 3 % masing-masing. Min untuk pencapaian masa, kos dan kualiti juga telah meningkat sebanyak 22%, 9.6% dan 3% masing-masing. Sisihan piawai untuk pencapaian masa dan kualiti pula telah menurun sebanyak 38% dan 62% masing-masing manakala untuk pencapaian kos ianya didapati meningkat lagi disebabkan peningkatan yang mendadak ke atas pencapaian kos dalam satu projek yang tidak tertakluk kepada tindakan kawalan.

Sementara tahap pencapaian projek-projek yang tertakluk kepada tindakan kawalan meningkat dengan nyata sekali, tahap pencapaian untuk masa dan kos di projek-projek yang tidak tertakluk kepada tindakan kawalan merosot sebanyak 2.64% dan 8% masing-masing. Peningkatan tahap pencapaian yang nyata sekali yang tercapai dalam beberapa projek yang tertakluk kepada tindakan kawalan menggunakan sistem kawalan ini membuktikan bahawa penggabungan ukuran pencapaian kualiti dapat mempertingkatkan keberkesanannya untuk mengawal pencapaian projek.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks and gratitude to Assoc. Prof. Dr. Ir. Md Yusof Ismail, the Chairman of the Supervisory Committee, Assoc. Prof. Dr. Hamzah Abdul Rahman and Prof. Ahmand Rosdan Abd Razak, the members of the supervisory Committee for their supervision, encouragement, valuable suggestions and friendly advice given to me throughout the period of this study.

I would also like to thank my QA and Planning Department staff for their assistance in collecting the various data that was required from the case study projects that was required for this research. My sincere thanks also goes to my colleagues who provided valuable assistance to the audit teams assigned to investigate the processes that was causing the shortfalls in some of the projects.

Most of all I would like to thank my spouse, Faizah for her continuous support and encouragement and to my children who have always motivated me to complete the research work that I began in the year 1999.

Finally may all praise be to God Almighty, the Creator and Sustainer of the Worlds Who is Perfect in Wisdom and Knowledge for taking care of my needs and enabling me to complete this work

I certify that an Examination Committee met on 18 October 2004 to conduct the final examination of Abdul Rahman Ramakrishna Bin Abdullah on his Doctor of Philosophy thesis entitled "Integration of Quality Measure in Project Control System for Construction Organizations" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the examination committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any degree at UPM or other institutions.

ABDUL RAHMAN RAMAKRISHNA BIN ABDULLAH

Date:

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LIST OF ABBREVIATIONS

ABC	Activity Based Costing
ACMWP	Actual Consumption of Materials for Work Performed
ACWP	Actual Cost of Work Performed
ARMWP	Actual Requirement of Materials for Wok Performed
ATE	Actual Time Expended
BAL	Budgeted at Completion
BCWP	Budgeted Cost of Work Performed
BCWS	Budgeted Cost of Work Scheduled
BIE	Bouwcentrum International Education
BRE	British Research Establishment
CEO	Chief Executive Officer
CIDB	Construction Industry Development Board
CII	Construction Industry Institute
CMGD	Certificate of making good defects
CONC	Cost of Non-Conformance
COQ	Cost of Quality
CPC	Certificate of Practical Completion
CPI	Cost Performance Index
CR	Critical Ratio
CV	Cost Variance
DLP	Defects Liability Period
DO	Delivery Order
EAC	Estimated at Completion
EQI	Execution Quality Index
ETC	Estimated Time at Completion
F & A	Finance and Accounting
HR	Human Resources
JIT	Just-In-Time
LAD	Liquidated Ascertained Damages
MIER	Malaysian Institute of Economic Research
MOS	Material on-site
MQI	Material Quality Index
NEDO	National Economic Development Office
OD	Original Duration
PAF	Preventive, appraisal and Failure Cost
PMC	Project Management Consultant
PO	Purchase Order
POC	Price of Conformance
PONC	Price of Non-Conformance
PWD	Public Works Department
QA	Quality Assurance
QPI	Quality Performance Index
QPMS	Quality Performance Management System

QS	Quantity Surveyor
SPI	Schedule Performance Index
SV	Schedule Variance
TCPI	To Complete (the work) Performance Index
WAF	Waste Allocation Factor
WOH	Ministry of Health

GLOSSARY OF TERMS

Actual Cost of Work Performed (ACWP)

It is the cost incurred for accomplishing the work that was performed.

Advanced

The term "advanced" refers to improvements made on the existing to enhance the effective functioning of the system.

Appraisal Costs

The costs associated with measuring, evaluating or auditing products or services to assure conformance to quality standards and performance requirements.

Benchmarking

Defined as the process of continuously comparing and measuring an organization with business leaders anywhere in the world to gain information that will help the organization take action to improve its performance.

Budgeted Cost of Work Performed (BCWP)

Also referred as the earned value. It is the cost budget for the work that is accomplished.

Budgeted Cost of Work Scheduled (BCWS)

The BCWS is also referred as a time-phased budget against which the schedule performance is measured. It displays the distribution of cost through time and is displayed in the form of an S-Curve for typical building projects

Communication

It is defined as the process of interaction between individuals in which meaning is created and shared

Contracting organizations

Refers to construction contractors, i.e. both the main contractors and the direct or nominated subcontractors who enter into an agreement to construct and complete a construction project. The main contractor enters into an agreement with the project owner and undertakes to construct and complete the contract within the predefined objectives of the contract while the subcontractor enters into an agreement with the main contractor to undertake part or the whole scope of the works assigned to him by the main contractor. The main contractor typically provides the necessary financial and management services to ensure the physical completion of the contract, while the subcontractor provides the necessary resources and expertise to execute the scope of work that is assigned.

Control

The term "control" refers to guiding a project back on track

Cost of Non-Conformance (CONC)

It is the cost incurred due to failure of the existing process or product to meet the specified requirements.

Cost of Quality (COQ)

It is the total cost of ensuring quality and mistakes prevention, appraisal and failure costs.

Cost Performance Index (CPI)

It is the ratio between the cumulative earned value and the cumulative actual cost. It indicates the cost efficiency of the project to date.

Cost variance (CV)

It is the deviation between the cumulative earned value and the cumulative actual cost. It indicates whether the amount of money spent equaled the value of work done, or whether it was overspent or under spent.

Direct material waste

It is the loss of those materials, which were damaged and could not be repaired for subsequent use, or which were lost during the construction process.

Earned Value

Earned value is the sum of the budgets for the work that is complete. Therefore, earned value for completed activities is equal to the total budget. For activities not yet begun, the earned value is zero. Earned value is a means of placing a dollar value on project status.

Effectiveness

It is an output-side or results measure. It is about the identification of the right objectives – 'doing the right things' and taking actions that achieve those objectives. Effectiveness demonstrates whether an organization is doing the right things. It also informs of the extent to which planned activities are realized and planned results achieved.

Efficiency

It is the ability to produce the desired effect with a minimum of effort, expense or waste.

Execution Quality Index (EQI)

It is an index for the combined performance of both the efficiency and effectiveness criteria of execution. It informs whether the overall performance of execution of work is acceptable or otherwise.

Failure costs

Failure costs represents waste; they are genuine losses because they would not be expended if quality were perfect. Internal failure costs occur prior to delivery and external failure costs occur after delivery of the product to the customer.

Indirect material waste

It is a monetary loss resulting from the waste such as substitution of materials and use of materials in excess of quantities.

Internal Quality Audit (IQA)

Internal Quality Audit is conducted by the organization on itself for internal purposes. In addition to determining the state of compliance of execution to established requirements, it provides a means of validating the quality decisions, made during the process of execution.

Material Quality Index (MQI)

It is the ratio between the planned or billed quantity of materials for the work performed and the actual quantity consumed for doing the same work. The ratio indicates whether the state of effectiveness of execution of work on that material is acceptable or otherwise.

Material waste

Material waste is any material that is not used for the intended purpose of the project due to damage, excess, non-use or non-compliance with specifications, or being a by-product of the construction process

Performance

Performance is the execution or accomplishment of work.

Performance Indicator

It is a metric or combination of metrics that provide insight into a project or process to enable assessment and improvement.

Performance measurement system

It is the information system, which is at the heart of a performance management process, and it is of critical importance to the effective and efficient functioning of the performance management system.

Performance measures

Performance measures provide actionable information on a focused set of metrics to provide a balanced view of project performance that can be used to make decisions to improve the project management process. It also provides accountability by laying out what is expected, when it is expected and what action will be taken if planned achievements do not occur.

Prevention costs

The costs of activities specifically designed to prevent poor quality in products or services.

Productivity

It is the relationship between what comes out of the organizational system in terms of products and services and what goes into the organizational system, in terms of the resources consumed to generate those products and services.

Project

A project is a series of activities undertaken by a group of people which is intended to achieve a result.

Project controls

Project controls are the techniques, methods, tools and style of implementation used to control the time, cost and quality of a project

Project control system

Project control system is a set of interrelated or interacting elements that are used to control the time, cost and quality of a project. The system provides a sound basis for problem identification, corrective actions and management and planning that may be required

Project evaluation

It is an appraisal of the actual progress against what was originally planned. It results in suitable indicators that are reflective of the actual performance.

Project management

Project management is a set of methods, techniques, tools, interacting with other fields – general management, engineering, construction, information systems etc. – bringing some effective ways of dealing with various sets of problems.

Quality

Quality is pervasive throughout the entire organization system. It is variously defined; 'conformance to specification' or 'satisfying customers.' It is closely linked to effectiveness or even a sub-set of it. When quality is measured, the state of effectiveness therefore is highlighted.

Quality Performance Index (QPI)

It is the ratio between the cost of all the materials planned for the work that is performed, and the cost of the actual quantity of materials consumed for the work. It indicates whether the state of effectiveness of execution of work for the total project is acceptable or otherwise.