Development of a Benchmarking Model for Construction Projects in Kenya

Abednego Oswald Gwaya, Sylvester Munguti Masu, Walter Odhiambo Oyawa

Abstract- The construction industry is a crucial sector both for developed and developing economies. It contributes 10% towards GDP for developed economies and more than 4% for developing economies. The industry has often faced many challenges in form of cost and time overruns and quality issues. Project management was introduced as a solution to the perennial problems of cost, time and quality in execution of construction projects. But the much touted benefits are not always achieved leaving clients with a lot of disappointments. It can be argued that the traditional project management variables have been inadequate in the assessment and control of construction projects. This paper set out to develop the most appropriate project management variables for Kenya to enable achieve an efficient and effective construction industry. The purpose of this paper is to develop a project monitoring model for construction projects to fulfill two main objectives: to provide a project success index for every finished project in order to compare them with each other and to establish a benchmark for future improvement in success of construction project execution. The methodology adopted in this paper was, first, to undertake a literature review on existing methodologies. Then a research instrument in form of a questionnaire was developed and a survey approach was used. Based on a sample size of 580 members with a response rate of 344 members and or 59.4%, descriptive statistics and principal component analysis were employed for processing data to come up with project success criteria. The model's output is a project success index which is calculated based on seven project success criteria. The findings can be of valuable use both for academia in form of more research discourse in the field of project management and for industry participants in form of model application.

Keywords: Construction project, Project success criteria, Project monitoring, project success index, success factor.

I. INTRODUCTION

There is still a disagreement between project management researchers as to what constitutes project success and how it is to be measured Klagegg & Magnussen , (2005). De Wit (1988), and Pinto and Slevin (1988), mentioned that it is still not clear how to measure project success since project stakeholders perceive success or failure factors differently. Lim and Mohamed, (1999) believe that project success should be viewed from different perspectives of the individual owner, developer, contractor, user and the general public. Different projects have been executed in Kenya by the same project teams with varying results. The reason will be mainly due to leadership styles and clients' influences. But interestingly is where professors have been involved and still achieved less than optimal results example of extension of ADD building at the University of Nairobi (Muchungu, 2012). It is therefore necessary that we have a basis of organizations measuring and comparing performance of projects. This study aims to provide a basis for measurement of construction project success for construction projects in Kenya. The survey focused on developing a project success measurement model leading to one stand-alone measure for the construction projects. By applying this model the organizations are able to generally compare the finished projects and establish a benchmark for the current and future projects. In addition the model developed in this paper can be used as a guideline for other project-based organizations to initiate their own models. The study is premised on the hypothesis (H_0) that the project success is a function of cost, time and quality whereas H_1 states that project success is not a function of cost, quality and time alone.

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Dr. Abednego Oswald Gwaya, Lecturer, Department of Construction Management, Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya.

Sylvester Munguti Masu, Asst. Prof., Department of Construction Economics & Management, Technical University of Kenya, Nairobi, Kenya.

Walter O. Oyawa, Professor, Department of Civil Engineering Department , Jomo Kenyatta University of Agriculture And Technology, Nairobi, Kenya.

II. LITERATURE REVIEW

In his book, In Search of Excellence in Project Management, Kerzner (1998) discusses definitions of Project success, and provides a list of critical success factors that can affect project performance at different stages of a project life cycle. As he mentioned, the definition of project success has changed over the years. In the 1960s, project success was measured entirely in technical terms: either the product worked or it did not. In the 1980s, the following definition for project success was offered (Kerzner, 1998); project success is stated in terms of meeting objectives:

1) Completed on time,
2) Completed within budget, and
3) Completed at the desired level of quality.

The quality of a project was commonly defined as meeting technical specifications. Observe that all three of these measures are internal to a project, and do not necessarily indicate the preferences of the end user or the client. In the late 1980s, after the introduction of TQM, a project was considered to be a success by not only meeting the internal performance measures of time, cost and technical specifications but also making sure that the project is accepted by the client; and resulted in clients allowing the contractor to use them as a reference. Specifically, project management in construction encompasses a set of objectives which may be accomplished by implementing a series of operations subject to resource constraints. There are potential conflicts between the stated objectives with regard to scope, cost, time and quality, and the constraints imposed on human material and financial resources. These conflicts should be resolved at the

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onset of a project by making the necessary tradeoffs or creating new alternatives. Subsequently, the functions of project management for construction generally include the following (PMI, 2010):

1. Specification of project objectives and plans including delineation of scope, budgeting, scheduling, setting performance requirements and selecting project participants.
2. Maximization of efficient resource utilization through procurement of labour, materials and equipment according to prescribed schedule and plan.
3. Implementation of various operations; through proper coordination and control of planning, design, estimating, contracting and construction in the entire process.
4. Development of effective communications and mechanisms for resolving conflicts among the various participants.

The Project Management Institute focuses on nine distinct areas requiring project manager knowledge and attention (PMI, 2010):

1. Project integration management to ensure that the various project elements are effectively coordinated.
2. Project scope management to ensure that all the work required (and only the required work) is included.
3. Project time management to provide an effective project schedule.
4. Project cost management to identify needed resources and maintain budget control.
5. Project quality management to ensure functional requirements are met.
6. Project human resource management to develop and effectively employ project personnel.
7. Project communications management to ensure effective internal and external communications.
8. Project risk management to analyze and mitigate potential risks.
9. Project procurement management to obtain necessary resources from external sources.

These nine areas form the basis of the Project Management Institute's certification program for project managers in any industry.

Other major areas not addressed above but should be considered include:

10. Value engineering and concurrent engineering in relation to construction project management
11. Field/site construction project management.

III. GLOBAL QUEST FOR CONSTRUCTION PROJECT MANAGEMENT IMPROVEMENT

Generally, the built environment is known to constitute more than half of the national capital investment, account for the consumption of more than half of all the raw materials taken and it consumes between 40% and 50% of a country's energy (Du Plessis, 2002). According to the World Bank (1994), developing countries invest $200 billion a year in new infrastructure -4 percent of their national output and a fifth of their total investment. Regarding its socio-economic significance, the industry contributes about 50 per cent of all investments in capital goods in many countries (Zawdie and Langford, 2000). Even though the precise linkage between infrastructure and development is still open to debate, the World Bank (1994) Report asserts that infrastructure capacity grows in tandem with economic output: "a one percent increase in stock of infrastructure is associated with a one per cent increase in gross domestic product (GDP) across all countries". Contributing to the debate, Lopes et al. (2000) provided evidence, based on a study on data from 15 countries spanning 22 years, that "there is a critical level of construction value added (CVA)/GDP (at 4-5%) below which a relative decrease in construction volume corresponds directly to a decreasing growth in GDP per capita". Commenting on the socio-economic significance of infrastructure projects, Zawdie and Langford (2000) observes that good infrastructure projects can help enhance growth process by raising productivity, alleviate poverty by responding to the needs of the poor for better health, education, housing, transport and water and power supply services. Against this background, several countries at various levels of socio-economic development have recognized the need and importance of taking measures to improve the performance of their construction industry in order to meet the aspirations of its developmental goals (Ofori, 2000). This is in line with the agreements reached and reported by the CIB Task Group 29 (1999). According to Ofori (2000), the report agreed that "construction industry development is a *deliberate process* to improve the capacity and effectiveness of the construction industry in order to meet the demand for building and civil engineering products, and to support sustained national economic and social development objectives (CIB, 1999)". At that meeting, the report continued, it was agreed that construction industry development promotes:

(a) Increased value for money to industry clients as well as environmental responsibility in the delivery process;

(b) The viability and competitiveness of domestic construction enterprises.

This has become necessary because of the poor performance of the construction industry due to problems and challenges including those having to do with its structure characterized by fragmentation, institutional weakness and resource shortages (Latham, 1994; Egan, 1998, Beatham et al., 2004;). In the developing countries these problems are even bigger, compounded by lack of adequate resource and institutions to address them. These, together with the threat on the environment, have led to the call by various countries to work towards improvements in and sustainability of, the construction industry. Where, sustainable development has been defined as the "development that meets the needs of the present without compromising the ability of the future generations to meet their needs" (The Brundtland, 1987).

IV. CRITERIA FOR ASSESSING PROJECT PERFORMANCE BASED ON EXISTING PROJECT MANAGEMENT MODELS

The criteria in which project success/failure has often been assessed have also been called key performance indicators and even dimensions (Atkinson, 1999 Shenhar et al, 2002, Betham et al., 2004; Chan & Chan, 2004;). Several authors, within the multidimensional construct of project performance have proposed different criteria or indicators based on empirical research. While some focused on using these measures as strategic weapons, others emphasized the proper delineation of the measures and groupings into classes that

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will make tracking and management reasonable. Shenhar et al's (1996, 1997) model is based on the principle that projects are undertaken to achieve business results and that they must be "perceived as powerful strategic weapons, initiated to create economic value and competitive advantage, and project managers must become the new strategic leaders, who must take responsibility for project business results.". In their opinion, "projects in future will no longer be just operational tools for executing strategy –they will become the engines that drive strategy into new directions." The second premise is about the existence of project typologies, on the slogan "one size does not fit all". They propose that project success should be considered in four dimensions: *project efficiency, Impact on the customer, Business success and Preparing for the future.* These are to be assessed on the basis of four project types: *Low-tech, Medium-tech, High-tech and Super-high tech projects.* Vandevelde et al. (2002) summarized various works on project performance measurement which are based on the multidimensional, multi-criteria concept. In all, they identified seven dimensions: *respect for time, respect for budget and technical specification, knowledge creation and transfer, contribution to business success, financial and commercial success.* They merged these seven dimensioned model into a **three-polar model** namely, *process, economic and indirect poles***.** Atkinson (1999) separates success criteria into *delivery* and *post-delivery* stages and provides a "square route" to understanding success criteria*: iron triangle, information system, benefits (organizational) and benefit* (stakeholder community). The 'iron triangle', has *cost, time* and *quality* as its criteria (for the delivery stage). The post-delivery stages comprise:

(i) The Information system, with such criteria as *maintainability, reliability, validity, information quality* use;
(ii) Benefit (organizational): *improved efficiency, improved effectiveness, increased profits, strategic goals, organizational learning* and *reduced waste;*
(iii) Benefit (Stakeholder community): *satisfied users, Social and Environmental impact, personal development, professional learning, contractor's profits, capital suppliers, confident project team* and *economic impact to surrounding community*.

This model takes into consideration the entire project life cycle and even beyond. It thus lends itself for continuous assessment. Lim and Mohamed (1999), as reviewed by Chan and Chan, (2004), modelled project success measurement into '**micro viewpoint:** *completion time, completion cost, completion quality, completion performance, completion safety;* and **macro-viewp**oints: *completion time, completion satisfaction, completion utility, completion operation*. A key feature of this model is that it proposes only lagging indicators and gives no room for continuous assessment and monitoring. Below each view point are list of "factors" for measurement. Chan and Chan (2004) concentrated on construction projects, and, based on previous works (particularly of Shenhar et al 1997; Atkinson, 1999; and Lim and Mohamed, 1999), proposed a 15 key project indicators, key performance indicators (KPIs), comprising both objective measures: *construction time, speed of construction, time variation, unit cost, percentage net variation over final cost, net present value, accident rate, Environmental Impact assessment (EIA) scores;* and subjective measures: *quality, functionality, end-user's satisfaction, client's satisfaction, design team's satisfaction, construction team's satisfaction.*

Patanakul and Milosevic (2009) grouped their measurement criteria into three:

(i) criteria from organizational perspective: *Resource productivity, Organizational learning*
(ii) criteria from project perspective: *time-to-market, Customer satisfaction* and
(iii) criteria from personal perspective: *personal growth, personal satisfaction*.

Sadeh et al (2000) proposed a division of project success into four dimensions. These are:

(i) *Meeting design goals, benefit to end user,*
(ii) *benefit to the development organization,*
(iii) *benefit to the defence and national infrastructure,* in that order.
(iv) The benefit to the technological infrastructure of the country and of firms involved in the development process.

Finally, Freeman and Beale (1992) provided *technical success, efficiency of project execution, managerial and organizational success, personal growth, completeness and technical innovation* as the main success criteria. In effect, these authors are emphasizing the need to strategically assess project in dimensions that will facilitate its management for good performance. Taking from the often quoted adage of performance management: "if you cannot measure, you cannot manage", it is also true that: if you cannot measure appropriately, you cannot manage appropriately.

V. BENCHMARKING

Benchmarking is a tool that has been applied to many industries with notable success. It is about companies and organizations comparing their practices and performance in key activities. It is a useful tool based on the belief that it is possible to identify and examine the best practices of other organizations and then make constructive changes in one's own organization. Lema and Price (1994) stressed that benchmarking is the practice of comparing business and performance levels between divisions, competitors or world best, as part of continuous change and improvement. One advantage of benchmarking is that it can be applied in construction to both the product and the process with reference to time, quality and cost and any other appropriate variables.

A. Types of Benchmarking

Benchmarking is classified into various types depending on the company's strategy. Benchmarking can be divided into the following:-

Internal benchmarking compares performance between departments, units within an organization

External benchmarking identifies the competitor's product and then compare with own product.

B. Benefits of Benchmarking

Benchmarking has notable benefits and can be summarized in the following (CIB 1997);

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- Provides better understanding of customers' needs and their competitor's activities
- More customer's satisfaction
- Reduction in waste, quality problems and rework
- Faster awareness of important innovations and guides on how to apply to achieve profitability
- Provides strong reputation with their markets
- Increased profits and turnover

It can be observed that benchmarking is a powerful and useful tool to promote process changes and improvement that has been proved to be successful and could be used in construction industry to improve overall performance.

VI. RESEARCH METHODOLOGY

In this paper a success measurement model for construction projects is developed to find out how much the projects can be monitored, evaluated and compared once completed. This model has two applications; first it provides just one stand-alone measure as a basis which is comparable among finished projects and second it establishes a benchmark for improving the project success. The model is based on project success criteria. It compares well with Yeung et al, (2007) developed a model on Partnering Performance Index (PPI), which is composed of five weighted Key Performance Indicators (KPIs), to measure, monitor, improve, and benchmark the partnering performance of construction projects in Hong Kong, a weighting system applied for the project success criteria in order to consolidate different success measures to just one stand-alone measure for general comparison of the projects. A sample size of 580members randomly selected was utilized in this research. The response rate by the various respondents who participated in the research indicated an overall percentage of 59.4% or 344 members which was satisfactory to provide necessary information for the analysis. Data analysis was carried out using descriptive statistics and more advanced statistical tools. ANOVA was used to compare the two sets of variables using F-test and results compared. Principal Components Analysis was used as a factor reduction tool and later to establish the most appropriate project management factors for the benchmarking model development.

VII. RESEARCH FINDINGS

The main research findings are discussed hereunder.

VIII. KEY MANAGEMENT FACTORS FOR PROJECT MANAGEMENT ANALYZED THROUGH THE PCA METHOD

Key management factors of the project management for the various respondents' were analyzed through the Principal Component Analysis (PCA) method. The data for all the respondents' is as shown in table 1.1 below.

Table 1.1: Total Variance Explained on the Key Management Factors for Project Management

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
dimensi 1 on0	4.239	38.534	38.534	4.239	38.534	38.534	3.315	30.135	30.135
2	1.524	13.856	52.390	1.524	13.856	52.390	2.343	21.300	51.435
3	1.270	11.544	63.934	1.270	11.544	63.934	1.375	12.499	63.934
4	.969	8.806	72.740						
5	.737	6.701	79.441						
6	.626	5.691	85.132						
7	.475	4.319	89.451						
8	.359	3.265	92.716						
9	.304	2.761	95.477						
10	.282	2.560	98.037						
11	.216	1.963	100.000						

Kaiser-Meyer-Olkin Adequacy Measure (KMO): 0.787 Cronbach's Alpha 0.861 Rotation method: Varimax

Source: Field survey 2013

Cronbach's Alpha indicates 0.861 meaning the data is reliable. Equally, KMO at 0.787 is an indication that the sample size is adequate; hence it is possible to derive logical conclusions from the analysis of variables under consideration. The general data loadings are as shown in table 1.1 above; three components are essential for the analysis and can be interpreted into the following three categories namely; Integration and project management indicators, project performance management and value engineering. Category one has a greater variance that can be explained hence the eight variables are critical. Table 1.2 below shows that three components were extracted which can be renamed project management performance factor as component one; project execution efficiency as component

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two and value engineering as component three. The seven most important variables include: project information management, project scope management, project cost, project quality management, project integration management, project risk management and project time management.

Table 1.2: Clustering the Factors by the Component Matrix

	Component		
	1	2	3
Project Integration Management Factor	.648		
Project Scope Management Factor	.789		
Project Time Management Factor	.618	-.547	
Project Cost Management Factor	.767		
Project Quality Management Factor	.728	-.387	
Project Human Resource Management Factor	.262		
Project Information Management Factor	.839		
Project Risk Management Factor	.618		-.364
Project Performance Management Factor	.585	.653	
Construction Site Management Factor	.441	.640	.332
Value Engineering Factor	.072		.872

Source: Field survey 2013

From table 1.2 above project information management, project scope management, project cost management, project time management, project quality management, project risk management, project integration management and project human resource management are confirmed as key indicators. However, it should be noted that project integration and project information management are not consistent in loading. Project performance management factor is mainly a function of execution efficiency and effectiveness

IX. HYPOTHESIS TESTING

The hypothesis testing equations are as below:

$$H_0 : PMM = PT + PC + PQ$$

$$H_1 : PMM = PT + PC + PQ + PS + PH + PP$$

Source: Field survey 2013

Table 1.3 Hypothesis Testing of Between-Subjects Effects for the traditional factors of project management

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	55.724[a]	10	5.572	3.508	.000
Intercept	381.744	1	381.744	240.287	.000
Pro_time_mangment	3.530	2	1.765	1.111	.331
Pro_cost_mangment	2.516	2	1.258	.792	.454
Pro_qm_factor	10.124	2	5.062	3.186	.043
Corrected Total	519.624	302			

Dependent Variable:Name of the Profession

a. R Squared = .107 (Adjusted R Squared = .077)

Table 1.4: Hypothesis Testing of Between-Subje Effects for the proposed factors of project management

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	289.730[a]	41	7.067	8.089	.000
Intercept	576.356	1	576.356	659.715	.000
Pro_time_mangment	1.333	1	1.333	1.526	.218
Pro_cost_mangment	.000	0	.	.	.
Pro_qm_factor	39.734	2	19.867	22.741	.000
Pro_hr_managmnt	2.064	3	.688	.788	.502
Pro_sco_managment	.045	2	.023	.026	.974
Pro_perfoma_managmnt	29.274	4	7.318	8.377	.000
Corrected Total	515.130	299			

Dependent Variable:Name of the Profession

a. R Squared = .562 (Adjusted R Squared = .493)

Source: Field survey 2013

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The comparison of the two hypothesis testing tables as shown above using the f-values indicate that the f-value for table 1.3 model 1 (which compares time, cost and quality) is 3.508. This value is relatively low than that of the table 1.4 model (compares time, cost, quality, scope, human resource and performance) which is 8.089. The same can be compared using the adjusted r-squared values. For project cost under table 1.4 is a Z-report implying marginal errors. Consequently, because $f_{312(6)}cal$ = 8.089 is greater than $f_{312(3)}cal$ = 3.508 (both being greater than) the tabulated f-values; we conclude that the corrected model of the six project management factors implied by the alternate hypothesis is more efficient and effective to be applied in the construction industry in Kenya. The F table tabulated below shows $f_{312(6)}tab$ = 2.0985 which is less than (<) the $f_{312(6)}cal$ = 8.089. Similarly the $f_{312(3)}tab$ = 2.6049 which is less than (<) the $f_{312(3)}cal$ = 3.508. Therefore, we reject the null hypothesis and conclude that the alternate is true at the pre-determined confidence interval of 95%.

Equations 1.1 and 1.2 show the actual procedure of adding.

1. For Practitioners, this is reported as:

PMM =17.67%PT+18.80%PC+18.23%PQ+17.11PH + 14.47%PP + 13.72%PS.....1.1

b. For Clients:

PMMc = 0.5PF + 0.3PS + 0.10PC + 0.1.Pp……1.2

Where PMMc is the clients overall performance measurement PF is the client's project financial arrangements and preparedness. PS is the role of the client in clear scope definition and in scope change management process; PC is the level of the client coordination with consultants in ensuring a diligent execution of projects. Pp is the level and timely honouring of payments by the client to both the consultants and contractors. Overall project execution efficiency reflecting good project management is measured thus:

Pe = 82%PMM + 18%PMMc

Whereby Pe is the overall project execution efficiency;

PMM is the consultant and contractor contribution component as per equation 1.1. While PMMc is the client's contribution as per equation 1.2. An alternative approach would have been to interview persons who have had long-term experiences in execution of construction projects ranging from the middle managers to the senior project managers selected as panel of experts. A two way survey approach would then be used to validate views of respondents. Project success criteria would be sorted out by their average scores. The ones having the average score equal or less than 4 would be deleted based on a likert scale. By using Statistical Package for the Social Sciences (SPSS) software, the Mean Rank method would be applied for the rest of them in order to select top seven project success criteria to be used for the model. To determine whether there is degree of agreement among the panel of experts with respect to their rankings of the project success criteria, Kendall's Coefficient of Concordance would be used. The Kendall's Coefficient of Concordance says that the degree of agreement on a zero to one scale is:

$$W = \frac{12U - 3n(n-1)^2m^2}{n(n-1)^2m^2} \quad (1.3)$$

$$U = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} R_{ij}\right)^2 \quad (1.4)$$

where:

n = number of project success criteria m = number of experts R_{ij} = significant degree allocated for i^{th} project success criteria by j^{th} expert W = Kendall's Coefficient of Concordance.

X. PROPOSED PROJECT SUCCESS MEASUREMENT MODEL

The project success index will be calculated by using the following equation being the reduced form from equations 1.1 and 1.2:

PSI = 0.1449PT + 0.1541PC+ 0.1495PQ + 0.1403PH + 0.1187PP + 0.1125PS + 0.18PMM_C ----------(1.5)

Where: PSI: Project Success Index (Score range 0-1), PT: Project time performance PC: Project cost performance PQ: Project quality performance PH: Project Human resource performance, PS project scope Management, PP Project performance, PMMC: Project Client's performance. All seven success criteria should be measured based on an approach applied by each Project Manager in charge of a construction project.

XI. CONCLUSION

This paper presented a success measurement model for construction projects. The model uses seven project success criteria for measuring success of construction projects. As core competency of project-based organizations is to execute projects in an effective and efficient way, measuring how much a project was successful can play a key role to improve project management competency. In summary, there are two significant applications of the results we have obtained. First, we proposed one overall measure for success of the construction projects which can be applied for comparing construction projects in Kenya. Secondly the paper presents a practical success measurement model which can be simply applied or partially applied in construction projects. The model presented here was from construction project management point of view and it could be developed for other project stakeholders' points of view for future studies. Another suggestion could be developing a project success model for other projects in different industries based on the model proposed in this paper other than the construction industry.

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Abednego Gwaya
A. Academic Professional Qualification
B.A (Bldg. Econ.) Hons; University of Nairobi, MSc. (Civil Eng.); Makerere, Ph.D (Constr. Eng. & Mngt.); Jomo Kenyatta University of Agriculture and Technology (JKUAT) M.A.A.K. (Q.S); C.I.Q.S.K; Registered Q.S.

B. Specialization
Construction Project Management, Civil Engineering Construction, Contract Documentation, Project Management Modelling, Project Procurement Systems and General Quantity Surveying.

Ass. Prof. Sylvester munguti masu
A. **Academic Professional Qualification** B.A (Bldg. Econ.) Hons. M.A (Bldg. Mngt). Ph.D (Constr. Mngt.); University of Nairobi M.A.A.K. (Q.S); A.C.I. Arb; F.I.Q.S.K; Registered Q.S, (Q182). F.I.C.P.M (K).

B. Specialization
Construction Project Management, Construction Contract Documentation, Arbitration and Dispute Resolution, and General Quantity Surveying.

Prof. Walter odhiambo oyawa
A. Academic Professional Qualification
Professor, PhD, Structural Engineering (Kyoto University Japan) Msc. Civil Engineering, Bsc Civil Engineering (U.O.N); R. Eng., MIEK, MIABSE, Lead Expert-NEMA

B. Specialization
Professor of Civil Engineering, Civil Engineering materials, Project management and Structural Engineering.

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