Optimal Construction Resources Utilization: Reflections of Site Managers' Attributes.

Julius Ayodeji Fapohunda, Ph.D.[1*] and Prof. Paul Stephenson[2]

[1]Yaba College of Technology, Department of Building Technology, Yaba, Lagos State, Nigeria.
[2]Sheffield Hallam University, Built Environment Division, Sheffield, UK.

E-mail: bldrfapo@yahoo.com*

ABSTRACT

Construction projects are somewhat difficult to manage due to the nature of the industry. Thus, to optimize the utilization of construction resources, there is a need to evaluate site managers' attributes in order to establish the effects of these site managers' attributes on project product(s) delivery. This will also assist in ascertaining the essential attributes that could facilitate the construction production process and the optimization of the resources utilization by the site manager. The mixed method research approach was adopted to obtain quantitative and qualitative information from site managers in UK construction organizations. Among the identified factors for resources efficient utilization are adequate knowledge transfer, timely availability of resources, efficient team integration, and team building. Highlighted findings in this paper will not only enhance site managers' efficiency and performances, but will also lead to effective resources waste management and improved organization profit and stakeholder satisfaction.

(Keywords: construction, production process, optimal resource utilization, resource waste management, site manager attributes)

INTRODUCTION

Construction projects are somewhat difficult to manage due to the nature of the industry; such as complex and unique projects, mobile workforce, diverse sub-contractors and suppliers; in addition to regulatory bodies and changes in government policies during the production process. These factors significantly affect the efficient performance of construction site management team. Currently, the historical gap between project design practices and the production is reducing; this is due to the emergence of several innovative and construction methods in practice. The use of the lean project delivery system, managing contracting, construction management in risk, turnkey project arrangements, partnering and the supply chain systems are now replacing the old traditional system. These innovative methods enhance resource utilization and make the products production and delivery process easier.

The mission of a site manager is to successfully accomplish construction project objectives and to deliver the project product(s) as stipulated in the project mission statement. These can be achieved through effective integration of several management techniques and the manager's in-built attributes from the project initiation to the project handing over. However, the delivery of a project product is often subjected to diverse constraints. In construction, conflicts exist between the projects' stated objectives with regard to the appropriateness of cost, time, and quality. In addition to these, adequacy, availability, and effective integration of construction resources (human, materials, and financial) are issues of concerns. These make it a requirement for a site manager to be proficient in integrating project scope with construction budget, schedule, and performance setting (Hendrickson, 2009; and Haughey, 2009).

In addition, effective project planning, co-ordination, control, and organization (Wideman, 1986; APM, 2006; CIOB, 2002; and PMI, 2005), effective communication and participants' motivation strategies (Griffiths and Watson, 2004) are important factors towards the manager's optimal resources utilization and satisfactory project delivery.

Much literature identifies the site manager fundamental attributes towards efficient resources utilization. The attributes (qualities, skills, and abilities (QSA)), highlighted by

Wideman (1996), Newcombe et al. (1993), Fraser (2000), and Hendrickson (2009) are good leadership traits, effective human management, eloquent communication skills, and negotiation power. As stressed by Haughey (2009) and Fapohunda et al. (2007), the following are also essential; effective planning, contract management and administration skills; problem solving; and conflict resolution abilities and creative thinking. In addition, Haughey (2009) emphasized that the ability to inspire; shared vision, integrity, enthusiasm, empathy, competency, effective authority delegation and team-building are paramount towards delivery of project product(s) satisfactorily.

The distinct knowledge management areas for a project manager's efficient performance during construction production process, as emphasized in Wideman (1986), Dinsmore (1990), PMI (2005) and APM (2006), are:

a) Project integration management: this is to ensure that the various project elements are effectively coordinated.

b) Project scope management: this is to ensure that all the work required and only the required work is included.

c) Project time management: this is to provide an effective project schedule for project delivery.

d) Project cost management: this is paramount in order to identify needed resources and maintain budget control throughout the construction process.

e) Project quality management: to ensure functional requirements are met and delineation of construction non-conformances.

f) Project human resource management: to develop effective project personnel, team work and interactions for construction operation process.

g) Project communications management: to ensure effective internal and external communications and feedback from all the stakeholders.

h) Project risk management: to analyze, mitigate and foresee potential risks and change that may arise during the construction process.

i) Project procurement management: to obtain necessary resources from both internal and external sources as input and convert these resources effectively and efficiently towards output, construction product.

In addition, it is an important requirement for the site manager to possess adequate knowledge in materials and machinery management.

In summary, the three groups of management systems that require the proficiency of a site manager during construction production process are illustrated in Figure 1. Thus, the success factors of a site manager need to be related to the ability:

a) to integrate all management techniques effectively;

b) to utilize all construction resources, (materials, manpower, plant and equipment) efficiently; and

c) to deliver the construction product(s) within the project scope, (the project cost, delivery time, quality and stakeholders' expectation) satisfactorily.

These site managers' success factors are evaluated critically by exploring mixed method research approach in this research paper.

DATA COLLECTION AND ANALYSES

The theme, "site managers' attributes towards optimal construction resources utilization", is a part of a research study carried out towards the development and establishment of an "operational framework for optimal resources utilization during the construction production process". This part of the research work evaluated and established the reflections of site managers' attributes on resources utilization. Also, it presented the attributes that will enhance site managers' efficient performance towards resources waste minimization/avoidance during construction production process.

Mixed method research approach was adopted for triangulation purpose and to ensure the

validity and reliability of the inferences and findings. In addition, the approach was exploited to acquire the advantages of qualitative interview and quantitative questionnaire survey research methods and bridged their comparative demerits. The views of Arksey and Knight (1999), Kvale (1996), Frankfort-Nachmias and Nachmias (1996), Cohen and Manion (1985), and Bryman (2004) were scrutinized towards achieving the reliable outcome. All the information and data collected for this paper were obtained within the UK construction organizations.

Structured and semi-structured questionnaires were administered randomly. Questions were set on a significant number of site managers' attributes. Forty attributes were evaluated, and they were categorized into four groups, (the skills, potential, traits, and awareness). The site managers ranked these factors in scale 1 to 5, while 1 indicates "Not important" and 5 signifies "highly important. In addition, the respondents classified these attributes as either an essential or a desirable factor towards efficient resources utilization. One hundred and two completed questionnaires were collected, collated, and analyzed using Statistical Package for the Social Sciences, (SPSS). The findings obtained were ranked in order of importance and presented later in this paper.

The findings from the administered and analyzed quantitative research survey were used to structure questions which served as guide, investigated by exploring in-depth qualitative interview survey. Eight (8) site managers were interviewed, and all the participants had not less than fifteen years work experience as a manager in different multinational construction organizations.

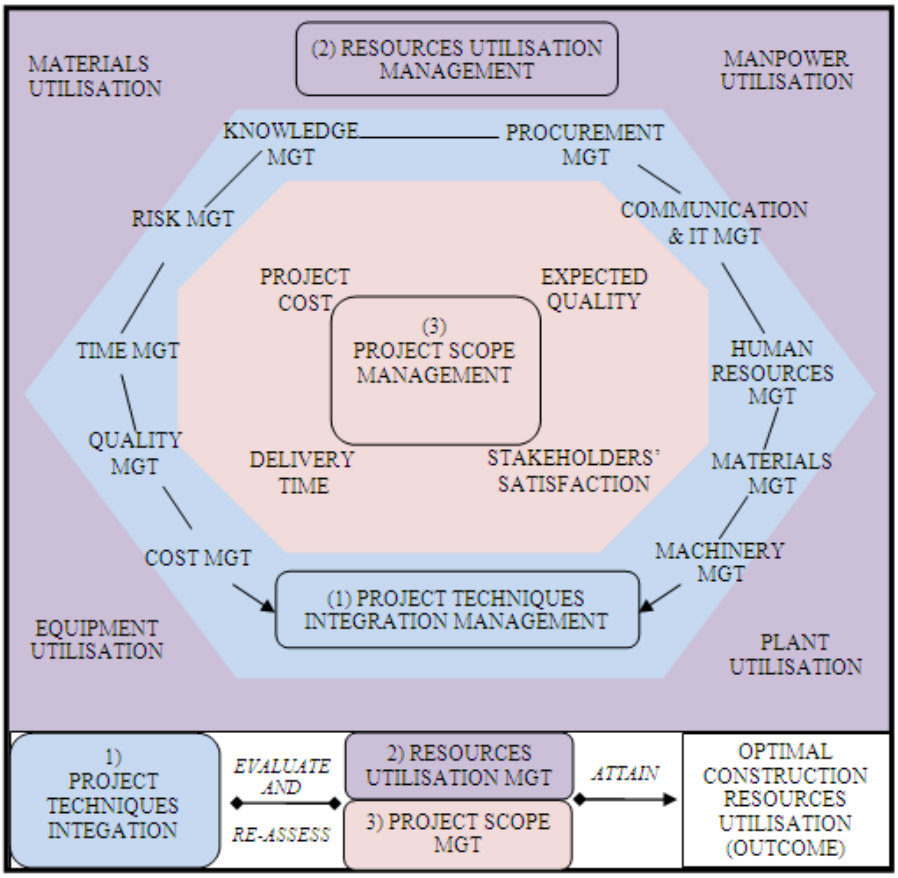

Figure 1: Construction Resources Management: Site Manager Success Factors Framework
Key: Management, (Mgt).

The respondents were solicited to comment on the results obtained through questionnaires' survey, and further advised to provide explanations on the following:

a) the significance of involving, (during the design stage), the construction site manager(s) who will execute the project construction;

b) the key roles of site managers towards optimal resources utilization during construction production process and how these roles could be enhanced; and,

c) the site managers' attributes that could be considered as essential towards efficient resources utilization and the underlying rationales.

The interview was recorded using digital audio recorder, and the information obtained was transcribed verbatim. The emergence themes were coded and collated using NVivo statistics software.

DATA PRESENTATION AND DISCUSSION OF FINDINGS FROM QUANTITATIVE RESEARCH SURVEY

Site Managers' Important Attributes towards Efficient Resources Utilization

The comparative importance of the site managers' attributes was drawn in percentage. The mean values of the groups evaluated are: Traits, 80%; Skills, 72%; Potential, 72%; and Awareness 67%, (Figure 2), and the detailed of the results are presented in Table 1 and Figures 3 to 6.

Table 1 presents the detailed results of all the site manager's attributes evaluated in order of importance. The majority of these factors have positive contributing effect towards enhancing efficient resources utilization. However, it was found that the four principal attributes, (highest percentage from each group), towards site manager's efficient performance and optimal resources utilization are leadership trait, risk management skill, decisiveness potential, and health and safety regulation awareness.

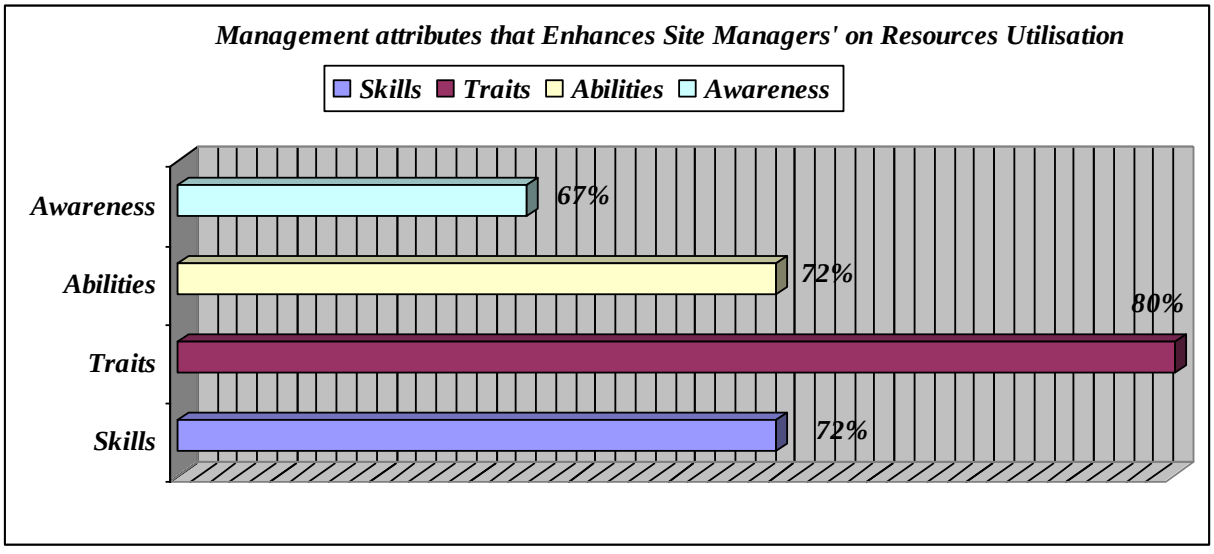

Figure 2: Mean Values of the Grouped Attributes that will enhance the Site Managers' Efficiency.

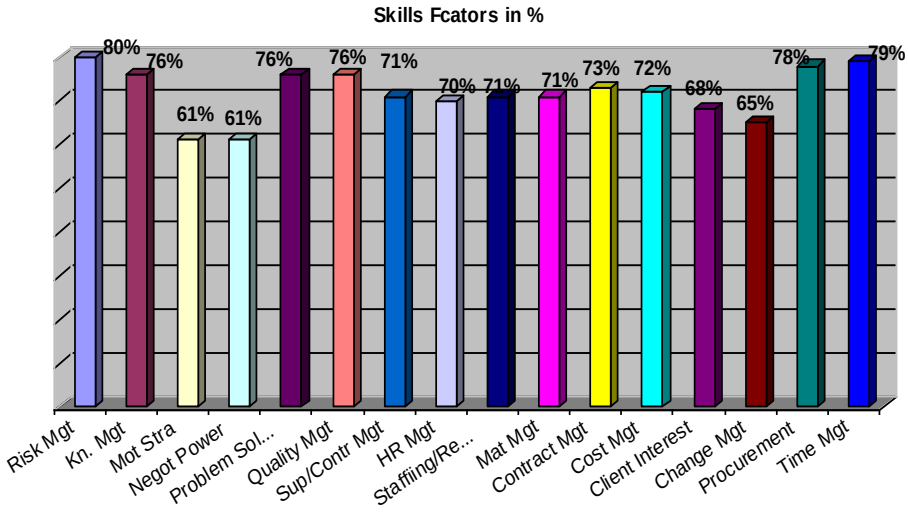

Figure 3: Skill Attributes.

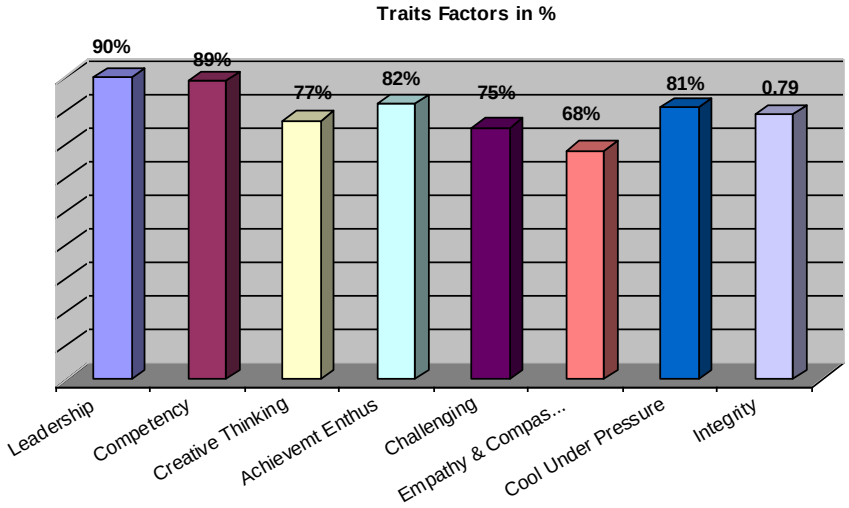

Figure 4: Trait Attributes.

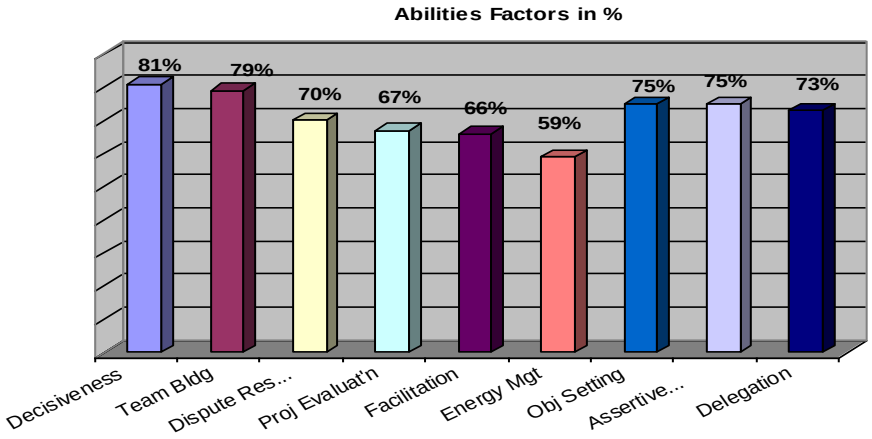

Figure 5: Ability Attributes.

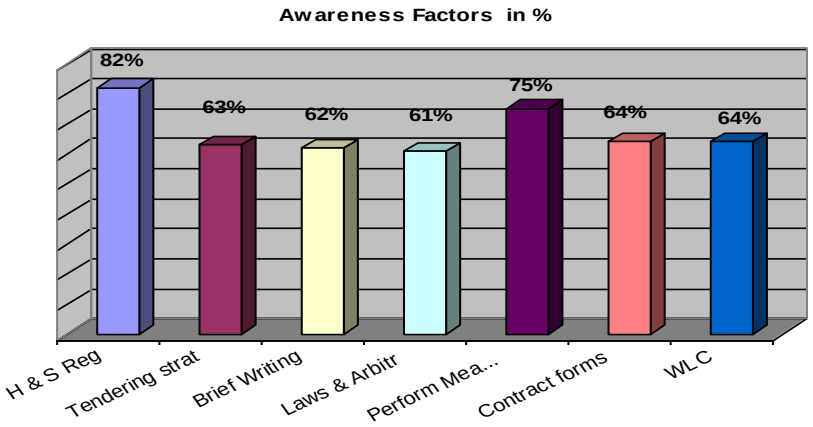

Figure 6: Awareness Attributes.

Table 1: The Attributes that will Enhance the Site Manager's Efficient Performance in Order of Importance.

Order of importance	A) Skills	Mean 72%		B) Traits	Mean 80%		C) Abilities	Mean 72%		D) Awareness	Mean 67%
1.	Risk management	80%	1	Leadership	90%	1	Decisiveness	81%	1	Health & safety regulations	82%
2.	Time management	79%	2	Competency	89%	2	Team building	79%	2	Performance measurement	75%
3.	Procurement management	78%	3	Enthusiasm in achievement	82%	3	Objective setting	75%	3	Contract forms & strategies	64%
4.	Knowledge management	76%	4	Cool under pressure	81%	4	Assertiveness	75%	4	Whole life costing	64%
5.	Problem solving	76%	5	Integrity	79%	5	Delegation of responsibilities	73%	5	Tendering strategies	63%
6.	Quality management	76%	6	Creative thinking	77%	6	Dispute resolutions	70%	6	Brief writing	62%
7.	Contract mgt & administration	73%	7	Challenging	75%	7	Concurrent project evaluation	67%	7	Law and arbitration	61%
8.	Cost management	72%	8	Empathy and compassion	68%	8	Facilitation	66%			
9.	Staffing and Recruitment	71%				9	Energy management	59%			
10.	Materials management	71%									
11.	Suppliers & sub contractors management	71%									
12.	Human resources management	70%									
13.	Client interest management	68%									
14.	Change management	65%									
15.	Motivation strategies	61%									
16.	Negotiation power	61%									

The least rated from each group are: empathy and compassion trait, negotiation power skill, energy management potential, and law and arbitration awareness. To buttress the findings' reliability, an interview survey was conducted and the report is presented later in this paper.

Essential and Desirable Site Manager's Attributes towards Efficient Resources Utilization

Further investigations were made to ascertain the essential and desirable attributes that site managers require and to emphasize efficient resources utilization during construction production process. These essential and desirable factors were collated in rank order of importance are presented in Table 2; in addition, the degree of the factors being essential or desirable are indicated.

These essential factors are the "opportune" attributes which site managers require to emphasis and "strengthen" in order to guard against opposing "weakness" and "threat" towards optimizing resources during the construction production process. Forty factors were identified and evaluated, among these, thirteen are found to be desirable, while the rest are essential.

Table 2: Essential and Desirable Factors towards Achieving Efficient Resources Utilization, the Order of Importance.

Essential and Desirable Site Managers' Attributes, the order of Importance			
(i) Essential Attributes	%	(ii) Desirable Attributes	%
1. Supplier and Sub-Contractor Mgt (SA)	92	1. Empathy and Compassion (TA)	77
2. Quality Management (SA)	87	2. Facilitation (PA)	77
3. Leadership (TA)	85	3. Contract forms & strategies (AW)	77
4. Competency (TA)	82	4. Negotiation Power (SA)	76
5. Energy Management (PA)	82	5. Tendering strategies (AW)	73
6. Risk Management (SA)	81	6. Brief Writing (AW)	70
7. Enthusiasm in achievement(TA)	81	7. Change Management SA)	68
8. Health & Safety Regulation (AW)	79	8. Motivation Strategies (SA)	67
9. Knowledge Mgt & Shearing (SA)	78	9. Laws and Arbitration (AW)	65
10. Cost Management (SA)	77	10.Contract Mgt & Admin (SA)	63
11. Materials Mgt (SA)	71	11.Concurrent Project Evaluation (PA)	57
12. Integrity (TA)	71	12.Whole Life Costing (AW)	56
13. Team Building(PA)	68	13.Challenging (TA)	52
14. Cool Under Pressure(TA)	62		
15. Delegation of Duty(PA)	59		
16. Performance Measurement (AW)	59		
17. Client Interest management (SA)	59		
18. Procurement Management (SA)	57		
19. Problem Solving (SA)	57		
20. Time Management (SA)	56		
21. Objective Setting (PA)	55		
22. Decisiveness(PA)	55		
23. Assertiveness (PA)	55		
24. Dispute Resolutions (PA)	54		
25. Staffing And Recruitment (SA)	54		
26. Creative Thinking (TA)	52		
27. Human Resources Mgt (SA)	52		

Key: Skills, (SA); Traits, (TA); Potential, (PA); Awareness, (AW)

It could be observed from the Table 2 that the ratings associated to the desirable factors are all above average, while some are very high. These indicate that these desirable factors are not insignificance towards the site managers' efficient performance.

Further investigations are made during the interview survey research to validate these results and to ascertain how these factors could be improved.

Reliability and Validity Test Statistics

Tables 3 a, b, c and d show the reliability and validity tests' statistics of samples obtained on the site managers attributes towards efficient utilization of construction resources. The value of "Cronbach's alpha coefficient" of a factor is significant when it is within the range of 0.7 (weak) and 1.0 (absolute), (Field, 2005; and Coakes and Steed, 2003).

Table 3(a): Reliability and Validity Tests' Statistics of all the Variables – Skills/Expertise Attributes of Site Manager.

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall Cronbach's Alpha Coefficient	Chi-Square (Sig.)	ANOVA (Sig.)
Knowledge management	.390	.899	.899	.001	.001
Human resources management	.413	.898		.001	
Materials management	.401	.898		.001	
Cost management	.450	.897		.001	
Quality management	.566	.894		.001	
Risk management	.696	.888		.001	
Time management	.585	.893		.001	
Procurement management	.649	.892		.001	
Staffing and recruitment	.671	.889		.001	
Negotiation power	.656	.890		.001	
Problem solving	.673	.890		.001	
Contract mgt & administration	.736	.887		.001	
Client interest management	.560	.894		.017	
Suppliers & sub-contractors mgt	.567	.893		.001	
Motivation strategies	.642	.890		.001	
Change management	.522	.898		.001	

Table 3(b): Reliability and Validity Tests' Statistics of all the Variables – Traits/Qualities Attributes of Site Manager.

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Leadership	0.653	0.843	0.862	.001	.001
Integrity	0.612	0.845		.001	
Enthusiasm in achievement	0.683	0.838		.074	
Empathy & compassion	0.563	0.854		.025	
Competency	0.481	0.859		.001	
Cool under pressure	0.664	0.840		.001	
Challenging	0.722	0.832		.001	
Creative thinking	0.563	0.852		.001	

Table 3(c): Reliability and Validity Tests' Statistics of all the Variables - Awareness Attributes of Site Manager.

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha Coefficient	Chi - Square (Sig.)	ANOVA F-test (Sig.)
Delegation of task and responsibilities	.622	.901	0.907	.001	.001
Assertiveness	.794	.890		.001	
Objective setting	.735	.893		.001	
Decisiveness	.767	.892		.001	
Team building	.792	.889		.001	
Facilitation	.692	.896		.001	
Concurrent project Evaluation	.530	.909		.001	
Energy mgt	.693	.897		.001	
Dispute resolutions	.604	.902		.001	

Table 3(d): Reliability and Validity Tests' Statistics of all the Variables - Awareness Attributes of Site Manager.

Factors	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted	Overall total Cronbach's Alpha coefficient	Chi-Square (Sig.)	ANOVA F-test (Sig.)
Performance measurement	.577	.776	0.805	.001	
Contract forms & strategies	.587	.773	0.846 - The Alpha Value when "Heath and Safety Regulation" Item is deleted	.001	
Tendering strategies	.656	.758		.001	
Law & Arbitration	.616	.765		.001	.001
Whole life costing	.621	.765		.001	
Brief writing	.617	.765		.001	
Health & safety regulations	.208	.846		.001	

By examination of the characteristics of the scale, the following facts are deduced:

a) the "corrected item of total correlation coefficients" of all individual factors > 0.3;

b) the "overall Cronbach's alpha coefficient" > all individual items "Cronbach's alpha if the item is deleted" value.

These (i) and (ii) indicate that, there exist internal consistencies between the values of data collected.

The values of "Cronbach's alpha coefficient" of factors considered on site managers' "skills" is 0.899; "traits" is 0.862 and "ability" is 0.907; also, the individual factor value of "corrected item-total correlations" is greater than 0.3; thus these show that the results are reliable. The Awareness "overall alpha coefficient" value is 0.805, however, if "health and safety regulation" item is deleted the overall reliability will be improved, and then the value will be 0.845, Table 3(d).

An ANOVA test statistics was conducted to find the difference in mean value of the samples, and the value obtained indicates a strong agreement between the respondents' responses, and signifies that the samples share a common trait (sig. < 0.05).

The validity of the results obtained on skills attributes were confirmed when all the samples chi-square results, Table 3(a) registered ($p < 0.05$). This shows that there is strong significant association between the variables. These validity and ANOVA deductions also applied to items on traits, abilities, and awareness responses obtained, Tables 3(b) to 3(d).

QUALITATIVE INTERVIEW RESEARCH REPORT

Based on qualitative interview research conducted, the essential roles and attributes of a site manager towards successful project delivery were established. These will also enhance the manager's efficiency and performances.

Roles of Site Managers in Project Execution

The questions presented during the interview are:

a) What are the effects of involving a project or site manager that will execute the project during the design stage, in relation to efficient resources utilization?

b) What are roles of construction site managers in any type of project procurement system towards reduction of resources wastage?

The identified principal roles of a site manager towards efficient project execution are:

1. Team integration: to integrate the finance, construction, and design teams together. Also, the Manager is required to advise on how economic project delivery can be achieved through wastes

and cost reduction; delivering the project on time and at expected quality to stakeholders' satisfaction.

2. Team building: to identify and ensure that the right team(s) of workers are engaged to execute the project task(s), knowing their strengths and weaknesses. The manager is required to envisage significantly the workers' efficiency, quality, and skill needed to achieve the expected quality and accuracy of a specific task, and at first attempt.

3. Best procurement system: to advise the design team on the best procurement system that will enhance efficient resources utilization. Also, to ensure that construction resources are available when required, and as planned.

4. Technical advice: construction workers habitually expect efficient technical skill and explanation from the manager(s) even though the workers know what is to be done. Sub contractors often seek second opinion from the managers on site for clarification; thus construction site managers need to possess a broad experience of different trades.

5. Error identifications: a competent manager is expected to possess several resources procurement and specification skills. Thus, s/he needs to be able to provide adequate advice on alternative methods available towards efficient resources utilization; and be able to identify flops on production information presented by the design team before the project commences.

6. Presentation of effective alternative methods for construction production process: an efficient site manager should be able to advice on alternative methods that will minimize resources wastefulness to the client and client consultants. Though designers' attitudinal behaviors often jeopardize these efforts; the designers are habitually being adamant on their specifications and do appreciate the project aesthetics value with less consideration of resources' efficiencies.

7. Planning towards resources wastes' minimization and/or avoidance: need to work towards wastes' minimization and to eliminate the avoidable ones, which might have being unconsciously incorporated into the design package.

8. Effective and efficient communication and information dissemination: a site manager needs to possess the ability of communicating effectively, especially when new concepts or construction methods are introduced or required for executing atypical task, apart from the regular or traditional process which the project operatives may commonly be acquainted.

9. Project Planning, Monitoring, and Controlling: to ensure adequate planning is made for project execution before resources are ordered or procured. Also re-planning and monitor each task during project execution and to ensure that the set target is achieved.

Essential Site Managers' Attributes

The questions asked the interviewees to obtain the facts presented in this section are:

a) Kindly comment on the attributes of site managers in relation to efficient utilization of construction resources.

b) Which of the site manager's attributes could be considered essential towards efficient resources utilization and why?

From the interview survey, the essential site manager's attributes that will significantly enhance construction resources utilization during production process are:

1. Knowledgeable in Several Trades: A site manager should be able to exhibit considerable knowledge of many trades; explain work to be done to employees and disseminate information that demonstrates the skills required for performing the tasks efficiently. Though, it may not be expected of a manager to be an expert in all aspects of the specific project trades, thus, there may be a need for peculiar training(s) that will enhance

site managers being efficient in the project resources utilization.

2. Ability to Identify the Limit of Workers' Efficiencies: The manager should be able to identify the skill of the worker who could execute a specific task efficiently. This is achievable when site manager clearly know the quality and level of accuracy of the worker.

3. Awareness: No matter the proficiency of a site manager is, responsive awareness of key issues, factors and conditions of the project enhance efficiency. The ability to be aware of hindrances and to work towards their avoidance is essential. When a manager foresees a problem on time, without knowing the actual solution to the problem, the opinion of an expert can be sought before leading to chain problems.

4. Quality Management: Another important factor is quality management skills. Work performed to high standards at the first attempt avoids repetition, saves time loss and construction cost.

5. Motivation Strategies: A site manager should possess the ability to motivate site participants. This will leads to enthusiasm, and enhance/energize efficient performance.

6. Updated Health and Safety Policy: These need to be a prime concern of the site management. Workers tend to perform better in a favorable environment with adequate protective measures from hazards.

Enhancement of the Site Manager's Attributes

The following outlines are significant towards improvement of the site manager performances during construction production process:

1. Self-development and training: site managers need regular training, most especially on new innovations that could enhance efficient and effective resources utilization.

2. Efficient knowledge transfer: embracing staff development and knowledge transfer schemes within workers who have acquired experience in previous similar job(s).

3. Availability of adequate resources: the availability of adequate resources for a project at the appropriate time is essential for efficient resources utilization.

4. Efficient and effective team: availability of efficient and effective teams and experienced personnel for the project enhance site manager's performances, minimize resources' wastes and perpetuate optimal resources utilization.

TOPICAL ISSUES AND SUMMARY

The barriers that affect efficient resources utilization during construction production process in the industry include poor communication, disagreement, misunderstandings, bad weather, and construction participants' personality conflicts, (Haughey, 2008). Also, Griffith and Watson (2004) identify the five distinguished stages in which site managers need to be of high-quality during construction production process. These are project initiation, planning, production, monitoring and completion, in addition to the essential qualities a site manager require to possess, as stipulated in Newcombe et al. (1993) and Fapohunda et al. (2007). Therefore, to achieve the predetermined project objectives, the construction site managers should have a significant influence over four principal variables: time, cost, quality, and scope, which is possible through adequate integration of different management techniques. These make it paramount for the manager to have ability of excising authoritative and absolute control on project plan, staffing and recruitment, training and manpower development. Also, effective resources scheduling; ordering, procurement and storage of materials; equipment utilization; facilities and assets security; and workers health and safety are essential towards optimal resources utilization.

This paper presented the relative importance of different site manager attributes, and ascertained the factors that will significantly improve the manager's efficiency and performances on

resources utilization during construction production process. To obtained valid and reliable inferences, both quantitative and qualitative research surveys were conducted, and the findings were analyzed by exploring SPSS and NVivo statistics software accordingly. The results obtained were presented in tables and figures.

The paramount factors that are significant for effective and efficient utilization of construction resources, and resources' wastes minimization by the site managers include: (i) self-development and training: regular training on innovations that will enhance efficiency and effective resources utilization; (ii) efficient knowledge transfer: by incorporating staff development and knowledge transfer schemes within workers whom have acquired experience from similar jobs; (iii) availability of adequate resources for projects at the appropriate time and when needed, and, (iv) efficient and effective team building.

CONCLUSION

Successful delivery significantly depends on the efficient performance of the construction site manager, (through adequate utilization of construction resources), so the delivery of the project timely, at budgeted cost and quality expected are paramount to the stakeholders. Thus, the adequate implementations of these research findings will not only enhance the achievement of the predetermined project objectives and site managers' efficient performance, but will also improve the expected stakeholders' satisfaction

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SUGGESTED CITATION

Fapohunda, J.A. and P. Stephenson. 2010. “Optimal Construction Resources Utilization: Reflections of Site Managers’ Attributes”. *Pacific Journal of Science and Technology*. 11(2):353-365..