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CONSTRUCTION MANAGERS' (CMs) SKILLS AND PROJECT PERFORMANCE

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ABSTRACT

Stakeholders' attention in construction industry is always drawn to the issue of project performance as more project are characterised by cost over, time over and low quality of work. Different reasons for poor project performance have been identified among which is Construction Manager (CM) skills. This study therefore examines the relationship between CM skills and project performance of cost and time. 88 skills were identified from literatures and these were categorised under six major types; technical, managerial, legal, construction industry and business, people and financial skills. The study was conducted in Lagos state among randomly selected construction firms from sampling frame of Lagos State Tender Board and Building Price Book. Two sets of questionnaires were employed in gathering data for the study. A total of 145 questionnaires were distributed and 106 retrieved and valid for analysis representing 73% response rate respectively. The respondents were majorly CM and their superior. Using Principal Component Analysis with Varimax Rotation, six factors were extracted and a total of 28 skills indicators identified. Mean and Spearman Correlation Analysis were used in analyzing the data. The findings reveal that CMs possess all the identified skills and a significant relationship was found between overall CM skills and project performance of cost and time. It was therefore concluded that the more a CM possesses skills, the higher is the project performance in terms of cost and time. The study recommends that CM should be trained regularly to improve their skills and project performance.

Keywords*: *Construction, Construction Manager, Cost performance, Skills, Time performance

INTRODUCTION

The successful delivery of project in construction industry is of great concern to participant in the industry. It improves the profitability and competitive advantage of firms and generally promote good image of the firms. However, most construction projects experience cost overrun and time overrun (Dakas et al., 2004) and in some instances abandonment of the project (Ayodele & Alabi, 2011). The recurring question then is how to improve performance of construction project in terms of cost and time. Previous authors examines various ways of improving project performance vis-à-vis cooperative procurement procedures (Eriksson & Westerberg, 2011), Contractors' management capability (Aje, et al., 2009), Project characteristics (Cho, et al., 2009), Project health (Almahmoud, et al., 2012), Social capital (Di Vincenzo & Mascia, 2012), Supply chain relationship (Meng, 2012), Environmental factors (Akanni, et al., 2014), and Contractors/Project Managers skills (Jaafar & Khalatbari, 2013; Sunindiijo, 2015; Windapo, et al. 2015). Construction Managers (CMs) skills are said to affect project performance (Langer et al. 2008), how then do CMs skills affect project performance in terms of cost overrun and

time overrun. Based on this, the study seeks to find the relationship between CMs skills and project performance with the aim of improving construction project performance.

Previous studies examined the relationship between project managers 'skills and project performance using cost and time. These were measured subjectively. However, few studies concentrated on objective measures of cost and time. For example, Sunindijo (2015) examined the relationship between project managers 'skills and subjective measure of cost and time performance, the results show that interpersonal influence has positive relationship with time performance while emotional intelligence, interpersonal skills, apparent sincerity and budgeting influences cost performance. Jaafar & Khalatbari (2013) focused on the relationship between knowledge and technical skills of project managers and time performance, again time performance was subjectively measured. The study found that time management; scope management and risk management have significant effect on project time performance. Also, skill types like managerial skills and legal skills were not considered in Jaafar and Khalatbari's study. There is therefore a gap in objective measure of cost and time performance of construction project, this study therefore seeks to fill the gap by examining the relationship between CM skills and objective measure of construction project cost and time.

The findings of the study will assist construction firms to focus their human resource training and development on skills that are essential for good project performance. This will also assist them to create an enabling environment where CMs can develop and make full use of their skills. The study focuses only on the relationship between six CM skills namely technical skills, people skills, managerial skills, construction industry and business skills, legal skills, and finance skills and objective measure of cost and time performance. All, other factors are not considered in the study. The subsequent sections focus on review of literature on CM skills and project performance, the methodological issues and findings and conclusion.

LITERATURE REVIEW

Construction Managers Skills

Rigby and Sanchis (2006) define skills as knowledge, abilities and experience acquired before employment and during careers while Odusami (2002) describes skills as ability that can be developed which is apparent in performance. Thus, CM skills can be said to be the knowledge, abilities and experience related to construction work acquired by CM before employment and during careers for improved performance. CM skills in construction project can be classified into various types.

Many studies such as Edum-Fotwe and McCaffer (2000) and Farooqui, et al. (2010) identify different project managers' skills types based on different classification. Goodwin (1993) identifies essential project manager skills as conceptual skill, human skill, negotiating skills and technical skills while Windapo et al. (2015) broadly classify construction project manager skills as managerial skills, technical skills, personal skills and legal skills. Managerial skills were further subdivided into leadership skill, negotiation skills, problem solving skills, project decision-making skills and communication skills.

Edom-Fotwe and McCaffer (2000) classify project manager skills as leading, communicating, negotiating and problem solving skills while Zadeh et al. (2016) concentrated on technical skills and human-related skills, Jaafar and Khalatbari (2013) focus on technical skills of project managers only. Sunindijo (2015) skills types include conceptual skills, human skills, political skills and technical skills. The interesting thing about the various categorizations of skill types is the fact that each skills types are further broken down into different types. Odusami (2002) identifies important skills of project manager as decision making, communication, leadership and motivation, problem solving, time management, organizing. Others include, planning and goal setting, technical knowledge, financial management, quality management, listening, delegating and negotiating. Conceptually, CM skills in this study can be classified as technical skills, managerial skills, legal skills, people skills, construction industry and business skills and finance skills.

Technical skill is a basic requirement in the implementation of projects including construction projects. According to Goodwin (1993), technical features of a project represents the elements of a project which must be integrated into the other elements of the system and conform to project requirement of cost, time and specification. In essence, technical skills are needed for integrating technical features of a project to conform to project requirement in terms of quality, time and cost. Katz in Goodwin (1993) defines technical skill as skill that entails understanding and proficiency in specific kind of activity majorly involving methods, processes, procedures or techniques. Technical skill further entails specialized knowledge, analytical ability within the specialty and facility in the use of tools and techniques of specific discipline. Technical skills are further broken into forecasting techniques skills, site layout and mobilization skills, material procurement, operation research, technical writing, design activities and background, reading and understanding drawings, construction management activities, planning and scheduling, estimating and tendering, productivity and cost control, work study, plant hire and management and quality control, information and documentation, quality project structure, control and report, start-up and close out (Edum-Fotwe & MCcaffer, 2000; Jaafar & Khalatbari 2013).

Managerial skills are skills require for making business decisions and leading subordinates in an organisation. Edum-Fotwe and McCaffer (2000) identify CM managerial skills as leadership, time management, decision making, negotiation, delegation, strategic planning, human behaviour, motivation and promotion, recruitment, team working and top management relations. Farooqui et al. (2010) divide managerial skills required of CM into fifteen. They are health and safety management, quality assurance/total quality management, inspection/quality control, organizational, document control, project management administration and cost control. Others include leadership, team building, site planning and management, personnel/resource management, risk planning, assessment and control, productivity management, managing labour issues, knowledge and information management and financial management. Windapo et al. (2015) managerial skills include leadership, negotiation, problem solving, project decision-making and communication.

Financial skills are skills that involve competency in reporting systems, project finance arrangement, investment appraisal, VAT and taxation, stock control and evaluation, establishing cash flows and lastly, establishing budgets (Edum-Fotwe & McCaffer, 2000).

CIB skills: Farooqui et al. (2010) industrial and business skills include knowledge of health and safety regulations, knowledge of building codes and regulations, knowledge of environmental impact assessments, marketing with clients/developing client relations, knowledge on permitting process, construction trade knowledge. Others include understanding procedural issues, understanding cultural issues, appreciation of construction industry supply chain and partnering.

People skills: Elements of people skills are written communication, verbal communication, diversity, trade coordination, ability to speak different language /multilingual, meetings, managing relationship/networking/collaboration, motivation capabilities, negotiations/conflict resolution, coaching and mentoring (Farooqui *et al*., 2010).

Legal skills include skills on general legal background, drafting contracts, industrial relations, health and safety issues, preparation of claims and litigation and lastly trade unions and public authorities (Edum-Fotwe and McCaffer, 2000). Farooqui et al. (2010) identifies legal skills as interpreting contract documents, knowledge of construction law and legal environment, contract administration skills, knowledge of bidding procedures, dispute avoidance and resolution skills, knowledge of project delivery and contracting strategies, change management, understanding labour laws, claims preparation and presentation skills and lastly claims defence skills.

Project Performance

The main objective of construction project is to complete project within the stated criteria, which serve as the measure of performance. Mwita (2000) defines performance as a multidimensional concept for achieving stated goals. Most performance measures in construction industry are at the project level and are measured in terms of cost, time and quality (Chan et al., 2002).

The determinant of project performance in terms of cost is the final cost of construction project. Cost can be measured using cost or percentage of net variation over final cost (Chan, 2001). Unit cost is a measure of relative cost and is defined as the final contract sum divided by gross floor area. Percentage net variation over final cost is the ratio of net variations to final contract sum expressed in percentage form (Chan, 2001). The budget of a project at the beginning is usually use as reference point to determine cost overrun (Love, 2012). The cost performance of project is measured by comparing the budget cost to the final cost of the project which is usually in percentage. Previous authors like Meng (2012), Memon, et al. (2012), Ade-Ojo and Babalola (2013) measure the performance of project based on cost overrun. The results show that most construction project performs poor due to cost overrun.

Timely completion of construction project is one of the objectives of construction project, it is therefore important that a project is completed within the stipulated time. Previous authors like Xiao and Proverbs (2002) measures project performance in terms of time. According to Chan (2001), time can be measured in terms of construction time, speed of construction and time overrun. He explains construction time to be absolute time from project commencement date to practical completion date, Speed of construction as gross floor area divided by the construction time in day/weeks. Variation is measured as percentage of increase or decrease in the estimated project with reduction of extension of time granted by the client.

CM skills and project performance

Previous studies (Langer et al., 2008; Haggerty, 2000; Jaafar and Khalatbari, 2013; & Windapo et al., 2015) found a relationship between CM skills and project performance. It was also discovered that CM skills play a very important role in project delivery. Therefore, it could be said that CM skills affect project performance in terms of project cost and time through the skills types possessed by CM.

As mentioned previously, several studies tested the relationship between CM skills and project performance, although most studies focused on subjective measure of project performance in terms of cost and time. Jaafar and Khalatbari (2013) propose a framework showing the relationship between knowledge and technical skills of project managers and time performance of power plant in Iran. The framework focuses on subjective project time performance only with exemption of cost performance. It also focuses on technical skills of project managers.

Sunindijo (2015) examined the relationship between PM skills of conceptual, human, political and technical skills and performance measure of scheduling, budgeting, quality performance, document and contract administration, risk management and procurement management. The results show a positive relationship between four CM skills of emotional intelligence, interpersonal skill, apparent sincerity and budgeting and project cost performance. Only one skill type of interpersonal influence has a positive relationship with project time performance.

Awan et al. (2015) investigated the relationship between soft leadership skills of project manager and project success. They conceptualized soft leadership skills of project manager as communication, interpersonal coordination, team building and delegation, problem finding, analyzing and solving skills. A significant positive relationship was found between each soft leadership and project success.

The relationship between the number of skills possessed by construction project managers and project performance in Lagos state was examined by Windapo et al. (2015). The independent variable which is construction project managers' skills were measured using communication, leadership,

decision making, problem solving, technical, personal effectiveness, negotiation and legal. The dependent variable was measured as the degree of client satisfaction with the project. The result shows a relationship between the numbers of skills CM possessed and project performance based on client satisfaction. The study did not consider cost and time as project performance.

Mixed results have been reported on relationship between skills and project performance. Based on this, it is thus hypothesized that:

H1. There is no significant relationship between skills types possessed by CM and project cost performance.

H2. There is no significant relationship between skills types possessed by CM and project time performance.

Based on the different skills types identified in literature above, the following are conceptualized to be skill types possessed by CM; Technical skills, Managerial skills, Legal skills, Finance skills, Construction Industry and Business skills and People skills.

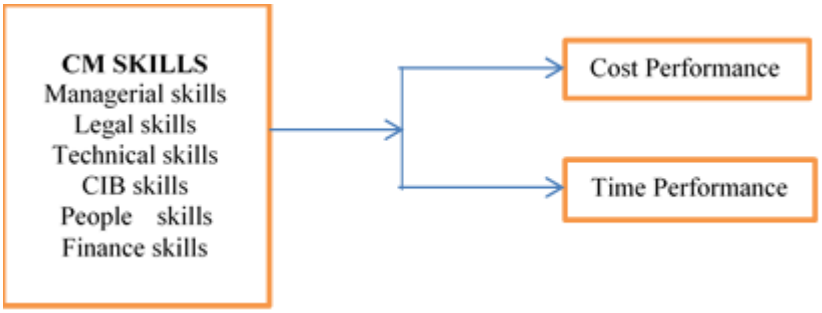

Figure 1: Relationship between CM Skills and Project Performance

METHODOLOGY

The research design adopted for this study is cross-sectional survey research. Two questionnaires were designed to find the correlation between CMs' skills and project performance. To achieve this goal, the first questionnaire measures the skills types of CMs while the second questionnaire is based on the initial and final cost and time of building projects. The samples for the study were selected from a sampling frame of construction companies in Lagos state. The sampling frame is gotten from the Lagos State Tenders Board list of registered construction contractors and Building price book. The list consists of 200 registered contractors. To arrive at the sample size, random sampling technique was employed in which every sample in the population has equal chance of being selected. Thus, a total of 145 questionnaires each was distributed from 134 sample size calculated using Yamane formular in equation 3.1. The construction projects used in this study were purposively selected based on the most recent completed building project executed by the selected firms. The CM in charge of the selected projects and his/her superior were thus asked to fill the questionnaires. A total of 106 questionnaires were retrieved and valid for analysis representing 73% response rate.

$$n = N/1 + (e^2) \qquad eqn. 3.1 \ldots\ldots.$$

Where n = Sample size
N = Population size
e = Level of precision (5%)

Based on the six CM's skills identified in literature, a supervisor's rated questionnaire was constructed. The questionnaire was partly adapted from Edum-Fotwe and McCaffer (2000), Farooqui et al. (2010), Jaafar and Khalatbari (2013) and Windapo et al. (2015). CMs superiors were asked to rate the skill types possessed by CM on a two-point scale of Yes =1 and No =2. The skill types were measured using latent and observable variables. The latent variables were broadly divided into managerial skills,

legal skills, technical skills, CIB skills, people skills and finance skills based on the literatures mentioned above. Managerial skill was measured with 22 items namely: leadership skills, time management skills, decision making skills, and so forth, legal skill has 11 items among which are: negotiations/Conflict resolution skills, interpreting contract documents skills, claims preparation and presentation skills. 17 items were used to measure technical skill (site layout and mobilization skills, material procurement skills, planning and scheduling skills, and so forth). 15 items were also used to measure CIB skills (knowledge of building codes and regulations, marketing with clients/ developing client's relations skills, knowledge of the permitting process, and so forth.). People skill was measured using 8 items (written communication skills, verbal communication skills, ability to speak different languages/ multilingual skills, and so forth.) Finance skill consists of 7 items (establishing cash flows skills, establishing budgets skills, finance reporting skills and so forth.).

Project performance was measured objectively using initial and final cost and initial and final duration of construction project. Initial project cost means the calculated cost of the project forecasted at the inception of the project measured in Naira while final project cost is the total cost of the project at the end of the project, also measured in Naira. Initial project time is the calculated time estimated at the beginning of the period measured in months while final project time is the total time spent on the project measured in months.

Project cost performance was further analysed using final contract sum minus initial contract sum divided by initial contract sum multiplied by 100. Project with percentage cost overrun above 20% was regarded as poor project and assign numeral 1, project with percentage cost overrun between 10% and 20% was regarded as average and assign numeral 2 and finally project with percentage cost overrun below 10% was regarded as outstanding project and assign numeral 3. This was based on Kometa et al. (1996).

Project time performance was also measured in terms of time overrun using final contract duration minus initial contract time duration divided by initial contract time duration multiplied by 100. Project with percentage contract duration above 20% was regarded as poor project and given numeral 1, project with contract duration between 10% and 20% was given numeral 2 and regarded as average. Finally, project with contract duration below 10% was regarded as outstanding and given numeral 3. This was also based on Kometa et al. (1996). Table 1 presents the percentage cost overrun and time overrun for 10 of the selected projects.

Table 1: Cost Overrun and Time Overrun for Selected Projects

S/N	IC (N)	FC (N)	CD (N)	IT(Mts)	FT (Mts)	TD (Mts)	% CO	% TO
1	720000000	615000000	-105000000	12	8	-4	-17	-33
2	130000000	94762600	-35237400	9	7	-2	-37	-22
3	79000200	84761849	5761649	10	11	1	7	10
4	40000000	35004720	-4995280	4	3	-1	-14	-25
5	800000000	725000240	-74999760	9	7	-2	-10	-22
6	600000000	700254236	100254236	9	7	-2	14	-22
7	900000000	1300000000	400000000	14	19	5	31	36
8	3000000000	3500000000	500000000	36	48	12	14	33
9	450000000	455000000	5000000	12	12	0	1	0
10	80000000	80000000	0	5	5	0	0	0

Notes: IC- Initial Cost, FC- Final Cost, CD- Cost Difference, IT-Initial time, FT- Final Time, TD- Time Difference, CO- Cost Overrun, TO- Time Overall, Mths- Months, N- Naira

The values of cost overrun and time overrun in Table 1 show that the project cost and time performance based on Kometa et al. (1996) categorisation fall within the categorisation of poor, average

and outstanding performance. This confirms that the building projects considered are all within the range of poor, average and outstanding.

The Eighty CM skills were factor analyzed using principal component analysis with Kaiser Normalization and varimax rotation. The analysis extracted 6 factors with eigenvalues ≥ 1.00. 28 items were extracted from the original 80 items based on Stevens in Field (2005) recommendation; a factor loading is significant when it is greater than .512 for sample size of hundred. The 28 items were further classified under Six factors of CM skills namely; CIB skills with 7 items, Technical skills with 6 items, Finance skills with 5 items, Legal skills with 4 items, Managerial skills with 4 items and others skills with 2 items. See Table 2 for details.

Table 2: Factor Analysis of CM Skills

CM SKILLS	1	2	3	4	5	6
CIB SKILLS						
Knowledge of the permitting process	0.829					
Awareness of industry trends skills	0.808					
Understanding complimentary fields/ disciplines skills	0.684					
Marketing with clients/ Developing clients relations skills	0.684					
Knowledge of environmental impact assessments	0.661					
Construction trade knowledge skills	0.655					
Knowledge and information management skills	0.642					
TECHNICAL SKILLS						
Knowledge of construction materials		0.887				
Knowledge of construction equipment		0.845				
Construction management activities		0.733				
Planning and scheduling skills		0.572				
Material procurement skills		0.54				
Health and safety management skills		0.519				
FINANCE SKILLS						
Stock control and evaluation skills			0.804			
Establishing budgets skills			0.742			
Establishing cash flows skills			0.729			
Finance reporting skills			0.676			
Investment appraisal skills			0.634			
LEGAL SKILLS						
Interpreting contract documents skills				0.818		
Knowledge of bidding procedures				0.78		
Diversity skills				0.642		
Knowledge of construction law and legal environment				0.603		
MANAGERIAL SKILLS						
Human behaviour skills					0.831	
Motivation and promotion skills					0.655	
Recruitment skills					0.63	
Delegation skills					0.573	
OTHERS						
Project management/administration skills						0.769
Document control skills						0.765

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
a Rotation converged in 6 iterations

To determine the skill types possessed by CM, the mean of each skill variable was calculated. For the purpose of interpretation, skills with mean value between 1-1.50 were interpreted as 'Yes' while the skill types with mean value between 1.51-2.00 were interpreted as 'No'. The result is presented in Table 2. CM possessed all the skill types with mean value ranging from 1.06 to 1.18. Overall, CM possessed all the skills types with mean value 1.12 and SD 0.15.

Table 2: Skills types possessed by CM

CM Skills	Mean	Std. Deviation	Remark
Technical	1.06	0.17	Yes
Legal	1.09	0.22	Yes
Others	1.11	0.23	Yes
CIB	1.12	0.24	Yes
Management	1.13	0.24	Yes
Finance	1.18	0.29	Yes
Combined CM Skills	1.12	0.15	Yes

Note: 1-1.50 = Yes, 1.51-2.00 = No

To determine the relationship between CM skills and project performance and to test the hypothesis 'there is no significant relationship between CM skills and project cost and time performance. Spearman non-parametric correlation analysis was employed. This was because the data were not normally distributed. Table 3 presents correlation analysis results. When all the CM skills are combined together, the result shows a significant positive relationship in CM skills and project performance, thus the hypotheses were rejected at $p \leq 0.05$. The combined CM skills namely CIB, Technical, Finance, Legal, Management and other skills relate with cost performance (r= .229, p= .018) and time performance (r=219, r=.024). The implication is that the combined CM skills have influence on cost and time performance. The result in Table 3 also shows a non-significant relationship between individual CM skills and project cost and time performance except for legal skills. Legal skills have a significant relationship with cost performance (r= .226, p= .020) and time performance (r= .201, p= .039).

Table 3: Correlation between CM skills and project performance

CM Skills		Cost Performance	Time Performance
CIB	Correlation	0	.072
	Significance	.998	.461
Technical	Correlation	.071	.047
	Significance	.472	.634
Finance	Correlation	.182	.155
	Significance	.062	.112
Legal	Correlation	.226*	.201*
	Significance	.02	.039
Management	Correlation	.151	.086
	Significance	.123	.381
Others	Correlation	.032	-0.006
	Significance	.744	0.948
Overall CM skills	Correlation	.229*	.219*
	Significance	.018	.024

*Correlation is significant at the 0.05 level (2 tailed)

RESULTS AND DISCUSSIONS

From table 2, there is an indication that CMs who participated in the study have all the skills types (technical, legal, CIB, management, finance and others) with mean value of 1.12. The standard deviation which ranges from 0.17- 0.29 shows that there is little fluctuation on the level of agreement among the respondents on whether CM possesses the skills types. Ogundele et al. (2014) described the possession of skills as the act of acquiring productive assets which are transferred to the task. Thus, CM possessed skills that are transferrable to their task. While some CMs have little knowledge on different skills types, others have detailed knowledge. The level of skill possession determines the competency level of CM. The result is in line with Abas-Mastura et al. (2013) in which skills required for task were sufficiently acquired by employees. The result of the study also confirms Oladiran (2015) findings in which professionals working in construction firms were said to possess different skill types which are paramount in the execution of their task.

In finding the relationship between CM skills and project performance, a significant relationship was found between overall CM skills and project performance. This implies that CM skills influences project cost and time performance and an increase in overall CM skills will lead to an increase in project cost performance. Hence, when CM possesses the identified skills, there will be decrease in project cost and time overrun. This is in line with Jaafar and Khalabari (2013), Sunindijo (2015), Windapo et al. (2015) findings on the relationship between skills and project performance in which it was all concluded that there is a significant positive relationship exists between skills and project performance. This shows the importance of skills to CM in project execution as combination of the different skills will enhance and improve the performance of CM and subsequently the project.

Surprisingly, of all the individual significant CM skills identified in the study, only legal skills have significant relationship with project cost ($r= .226$, $p= .02$) and time ($r= .201$, $p= .039$) performance. This shows that the more a construction manager possesses legal skills, the better the cost and time performance in construction project. This also implies that when CMs have the skills of interpreting contract documents, knowledge of bidding procedures and knowledge of construction law and legal environment, then there will be better performance in terms of reducing cost and time overrun. Atout (2008) succinctly express that document control and proper detailed recording of contract document in a systematic way during construction period is one of the functions of CM. Thus, CM must possess legal skills to be able to perform this function which has strong impact on project cost and time performance.

CONCLUSIONS AND RECOMMENDATIONS

Cost and time performance is determined by different factors among which are the skills of CM. This study investigated the relationship between CM skills and project cost and time performance in Lagos state Nigeria. It was observed that CMs possess finance, legal, managerial and technical skills. Also, CM skills influences project performance and the more CM possess these skills; the more they perform better in terms of cost and time performance. Therefore, it can be concluded that increase in CM skills acquisition will lead to higher project cost and time performance. Based on this, CMs should focus on developing the identified significant skills so that they perform better in terms of cost and time performance. Construction firms should train their CMs for them to possess technical, managerial, legal and finance skills. They should focus their training and development in the areas of significant skills identified in the study. Future research should focus on replicating this study in other locations in the country and also focus on predicting project performance from CM skills.

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LAGOS PERI-URBAN HOUSING DEVELOPMENTS AND MANAGEMENT: CHALLENGES AND PLANNING INTERVENTION

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ABSTRACT

The aim of this study is to assess the existing challenges in the management of Lagos peri-urban and the intervention measures put in place by the regional government. Using case study approach and two-stage sampling techniques, the sample size constitutes heads of 370 housing units selected randomly from clusters of purposively selected 16 settlements in Ibeju-Lekki peri-urban. Purpose sampling was adopted to minimise cost because the settlements were dispersed over a wide geographical area. The Primary sources of data were structured interview and questionnaires administered through field survey to planning personnel and selected household heads respectively. Data analysis was done by using descriptive statistics. Findings show three levels of challenges as environmental, socio-economic and institutional. Notable among the challenges were flooding, industrial pollution, traffic congestion, rising cost of commodities, unaffordable land, lack of social facilities, land regularisation, inadequate land data and land speculation. Measures put in place to counter challenges include zoning, and effective town planning policy and management. It is recommended that the regional government should design a policy that would guide in managing the spatial pattern of growth and infrastructure distribution in Lagos peri-urban settlements. Also, this study should be conducted in other peri-urban settlements in developing countries.

Keywords: *Infrastructure, Institutional policy, Peri-urban, Planning intervention, Urban governance, Urban policy*

INTRODUCTION

The rapidity of development in the metropolitan fringe where local institutions have no authority to deal with contextual changes is the bane of sustainable development in Lagos peri-urban settlements. The complexity of the socio-economic and environmental changes in the peri-urban interface calls for urban planning intervention but the prevailing regulations have brought forth difficulty in managing and dealing with urbanization-related development issues (Cadène, 2005). Local and corporate governance is needed to participate in the process of urbanization through coordination of urban planning activities with relevant stakeholders in the metropolitan periphery (Obeng and Whittal, 2014). The existence of overlapping jurisdictions and poor local management often impact negatively on the provision of essential infrastructural services in the peri-urban settlements. Characteristics of peri-urban interfaces indicate that peri-urban areas are outside formal urban boundaries and urban jurisdictions and the rate of development could not be matched by proper development and planning of the peri-urban zones, thus poor infrastructure development (Lawanson *et al*; 2012).

Challenges to the governance of the peri-urban in developing countries appear in different forms with different stakeholders pursuing contradictory goals. Factional interest and individual objectives often overshadow corporate interest (Leaf, 2002). There is an institutional failure which translates to other challenges in Lagos peri-urban housing developments and ultimately impairs the characteristics of housing in Lagos peri-urban. Contributing also to the chaotic development pattern in metropolitan fringe is the lack of adequate monitoring of the continuous development by the building regulation

authority and lack of proper documentation of the pattern of growth as seen in most peri-urban developments in developing countries (Puttal and Ravadi, 2014). Poor spatial planning in the peri-urban is a contributing factor to hindered infrastructure development in the interface (Adell, 1999). Significant areas of peri-urban settlements are not state-managed hence leading to the emergence of organic and informal settlements. Poor living condition and lack of basic infrastructure facilities and services also abound in peri-urban settlements (Obeng and Whittal, 2014).

There exists a problem of mismatch between the nested jurisdictions of governmental administration in peri-urban areas. Original plans did not capture the speed of growth in peri-urban areas while they were also not backed up with infrastructure investments commensurate to this growth. Also affecting peri-urban- urban governance is deficient financial and human capital, this translates into inconsistencies in implementation and enforcement of planning regulations (DiGaetano and Klemanski, 1999; Firman, 2000). There is evidently no integrated advocacy group for implementation of urban planning in the urban fringe. Thus constituting a great challenge to the governance of peri-urban generally. The role of the local public sector in urban planning and development is also weak in comparison to the private sector (Connell, 1999).

Urban governance in Nigeria cannot be fully understood without reference to the three principal levels of power: the local, the state and the federal government. Each of these levels intervenes more or less directly in urban management (Jiboye, 2011). The lack of autonomy of the local governments, the arm directly responsible for urban governance responsibilities has contributed to the challenges of governing and managing development in the peri-urban of Lagos State. Therefore, this study seeks to examine the multidimensional challenges in the governing of peri-urban housing development in Lagos and the efficiency of existing intervention strategies.

LITERATURE REVIEW

Governance can be defined as the exercise of political, economic and administrative authority in the management of a country's affairs at all levels. It comprises the mechanisms, processes and institutions, through which citizens and groups articulate their interests, exercise their legal rights, meet their obligations and meet their differences (United Nations, 2006). Government and public institutions are major actors in the governance of the peri-urban. Government roles come through active participation done through land acquisition at government determined prices (Winarso, 2007). Among many issues hindering efficient governance of peri-urban settlements are duplicated jurisdiction in planning, land tenure, undefined title to land, lack of planning and building and regulations, inadequate infrastructural services and the influx of lower income residents resulting in informality in buildings. General characteristics of peri-urban settlements in developing countries are rapid land use change, land speculation, conflicting land tenure and unbalanced infrastructure provision for the growing population (Allen, 2010).

It is the responsibility of the local government to shape the peri-urban developmental pattern through effective political and economic institutions (Wu *et al*; 2013). This however has been reduced because the local government capacities to focus on strengthening collaborative approaches and interactive governance has been limited due to lack of autonomy (Hudalah *et al;* 2007). Also, city primacy in Nigeria, especially Lagos has resulted in unbalanced distribution of the development process and mostly the neglect of the peri-urban (Towry-Coker, 2002). Local government ability to generate revenue has collapsed, increasing their dependence and reducing their capacities to face the challenges of urban governance. Local governments of the peri-urban areas often have only limited personnel to enforce urban planning rules. This hinders good monitoring of the vast development in the urban periphery.

A host of the peri-urban challenges could be avoided by efficient regional planning practice. Developmental problems can majorly be attributed to the lack of effective urban policy and method (Daramola and Ibem, 2010; Jiboye, 2011). Effective governance is needed to create a balance between the growing population, the environment and infrastructure to improve on peri-urban environmental quality. Investigating the environmental challenges of peri-urban settlements in Lagos mega city,

Lawanson *et al*. (2012), identified security and poor infrastructure problems. The degree of infrastructure development in the peri-urban is a function of whether peri-urban housing is state-led or group-led. That is the influence of the initiative and developers are enormous on housing in the interface (Wu and Zhang, 2012). Land development control is pivotal in driving peri-urban growth (Webster, 2002). Due to the absence of land use development plan enforcement, land speculation thrives greatly in peri-urban settlements (Salem, 2015). Land zoning or land ceiling or price control is a tool that can be used in controlling peri-urban growth by sanctioning specific use in selective zones (Salem, 2015). Peri-urban housing is a product of distorted land market. The customary land tenure is a major hindrance to the development of the interface (Chirisa, 2010). Control of peri-urban growth calls for strict zoning regulation. Advocacy for neo-customary land control may help in contributing to compliance to zoning, supervision of land sales and resolution of land conflicts. In the absence of equitable land allocation, in a market-driven environment, low-income households with limited financial capacities are compelled to solve their shelter and livelihood problems informally thus constituting challenges to governance of the peri-urban (Fangzhu *et al*; 2013).

CONTEXT OF THE STUDY

The selected case study area is Ibeju- Lekki (Figure 1), a rapidly urbanizing Local Government Area located outside the metropolitan region of Lagos State. Ibeju-Lekki has grown phenomenally in the past ten years in terms of residential development and human population but not without accompanying environmental and socio-economic challenges. It is approximately 75 kilometres long and about 20 kilometres wide and has a land area of about 646 kilometres square, which equals one quarter of the total land mass of Lagos State. It is located at approximately latitude 40 15'north latitude 40 17' north and longitude 13015' east and 13020' east. According to the National Population Commission (2006) Census, Ibeju-Lekki had a population of 117,481 out of Lagos State's total of 9,113,605'

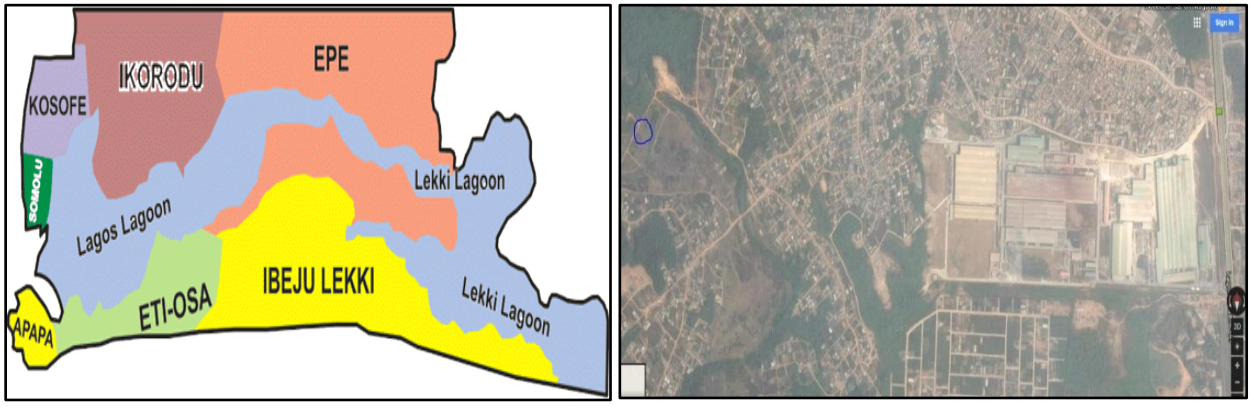

Figure 1: Map of Lagos showing Ibeju-Lekki, major primary and secondary roads

METHODOLOGY

Data for this objective were captured by both qualitative and quantitative method, using a structured interview and a survey questionnaire to capture respondents' perception on socio-economic, institutional and environmental challenges in the study area. Two sets of questionnaires were used to address this objective. The first set addressed issues of the multi-dimensional challenges in the study area. This set was administered to the heads of selected housing units in purposively selected 16 peri-urban settlements in Ibeju-Lekki to extract information on development and planning oriented challenges. The second set, an open ended structured interviews were to address planning issues. The structured interviews were targeted at information from planning officials. Twenty structured questionnaires were administered to personnel of all relevant planning institutions in the Local Government Area. Responses to the structured questions were recorded. Government offices visited were building control agency and the State Physical Planning Permit Authority in Ibeju-Lekki. Data processing and analysis on responses from closed ended questionnaires from housing units' representative was carried out using the Statistical

Package for Social Sciences (SPSS) 22. Descriptive statistics were used to present results in tables, charts and cross tabulation. Findings from the interview were analysed using content analysis.

RESULTS AND DISCUSSION

Socio-economic characteristics of the respondents

Analysis of the research questionnaires provided in Table 1 shows 36.6% of the population is involved in informal trading and commercial enterprises making it the predominant occupation in the study area. Aside other unknown occupations, farming is the least engaged among all the occupations considered. Civil service, skilled work and professional practices are well represented having 19.1%, 15.3% and 16.7% respectively. Only 9% of the respondents had primary school education and below thus constituting the illiterates in the study area. The predominant income group in the study area was the high income group earning above N150, 000.00 monthly. This income group constitutes 44.6% of the entire population. This runs contrary to the belief that most peri-urban is mainly dominated by the low income group and the middle income group. The low income group earning N25, 000.00-N50, 000.00 and living mostly in informal buildings and self-built housing is 36.3%. The middle income earning N50, 000.00-N150, 000.00 monthly income constitute 19.1% and the least represented in the study area.

Table 1: Household heads socio-economic profile

		Ibeju-Lekki	
		N=366	%
Occupation of household heads	Civil service	70	19.1
	Informal Trading	134	36.6
	Professional practice	61	16.7
	Skilled work(Artisan)	56	15.3
	Farming	1	0.3
	Others	44	11.9
Literacy level of household heads	Postgraduate	56	15.3
	First degree/Higher diploma	105	28.7
	National diploma	62	16.9
	Secondary	110	30.1
	Primary/Below	33	9.0
Monthly income of household heads	Low income (N25,000-N50,000)	133	36.3
	Middle income (N50,001-N150,000)	70	19.1
	High income (N150,001-Above)	163	44.6

(Source: Field survey, 2017).

Assessment of challenges to management in study area

Challenges to the governance of the study area can be viewed in three dimensions, environmental, socio-economic and institutional. While some challenges are existing challenges, some are potential problems related to the present trend of development and activities in the study area.

Assessment of environmental challenges in study area.

Based on the analysis of field survey presented in Table 2, poor environmental quality constitutes about 48.9% to the developmental challenges in Ibeju-Lekki. The present and potential environmental challenges in the peri-urban includes flooding, poor-quality environment, traffic congestion, industrial pollution and a high level of informal development. The challenges of flooding in the peri-urban is due to the existing flat terrain and inadequate drainage system in the study area. Often when it rains, the flooding issue usually limits pedestrian and vehicular movement thus contributing to traffic congestion. The impact of flooding during raining season in Ibeju is overwhelming. The analysis shows it contributes 41.2% to environmental challenge in the peri-urban. Massive migration to Ibeju-Lekki peri-urban due to housing challenges and the poor state of secondary roads is the major causes of traffic congestion in the peri-urban. This factor impacts negatively on the daily commuting hours in the peri-urban and constitute 2.5% of environmental challenges.

The challenge of industrial pollution is as a result of Ibeju-Lekki being home to some manufacturing and industrial activities thus creating both air pollution and water pollution through discharges into the water bodies. Most sources of water are mostly polluted through arbitrary discharges of effluents into them. Industrial pollution constitutes 3.8% of the challenges. The double standard system of land ownership in Ibeju-lekki is having its manifestation on the developments on lands not under the direct control of government. The cumbersome regularisation system put in place for self-help housing has pushed most household into informal developments in the peri-urban. This variable constitutes 3.6% of environmental challenges in the study area.

Table 2: Environmental challenges in the study area.

Variables	N=366	%
Flooding	151	41.2
Poor environmental quality	179	48.9
Traffic congestion	9	2.5
Industrial pollution	14	3.8
High level of informal development	13	3.6

Source: Field survey (2017).

Assessment of socio-economic challenges in the study area.

There exist some socio-economic challenges in Ibeju-Lekki peri-urban (Table 3, Figure 2), some of which are Lack of infrastructure development, inflation in the cost of commodities, escalation of land price, lack of social, unaffordable land, tenure conflict and cost of land security. The rapid development of Ibeju-Lekki peri-urban settlements outpaces the capacity of the regional government in provision of infrastructural facilities. Having earmarked the peri-urban for non-residential purpose originally coupled with the inefficiency of the planning authority to carry out timely reclassification of the emerging new towns from rural to urban in order to match the pace of growth. Peri-urban settlements suffer from high end neglect from the government. This is major institutional failure in Ibeju-Lekki peri-urban settlements.

Most of the communities lack basic facilities like water supply, electricity, medical facilities and children in school. This challenge constitutes 28.6% in the study area. The creation of rich elite communities in the peri-urban has the driven cost of consumable commodities up arbitrarily. Also the cost of travelling to the city centre for supply is factored into the final consumer prices by the retailer thus increasing the prices of regular commodities. This socio-economic challenge constitutes 33.7% from residents' perception. Escalation in the cost of land and unaffordable land for housing and related development comprise 20.4% and 5.2% respectively to the socio-economic challenges in the study area. This issue particularly is fueled by the activities of land speculators and the creation of high end gated

communities driving the cost land higher. Observation through the field survey shows a disproportionate distribution of social facilities like banking in the development of the peri-urban. Most household still rely heavily on the city centre for use of such facilities. This factors among other factors identified by the respondents and through the observation schedule as challenges to growth and management by 6.3%.

Land tenure conflict constitutes 2.5% to the socio-economic challenges. A fragile relationship exists between the land natives and the regional government because of the continuous forced acquisition of land by the government often leaving the original land owners deprived of their inheritance. Ibeju-Lekki peri-urban settlements suffer greatly from land conflict. As gathered through the interview sessions, the original land owners feel deprived and not well compensated for their rights. Many land conflicts have resulted in loss of lives, both of government officials and among the land owners. Cost of land security constitutes 3.3% in the study area. Land security in an urban system is through regularisation of building documents with the planning arm of the government. The lengthy processing time and the cost attached to assessment often discourage most migrants from attending to proper documentation of their land hence increasing informality. Informality at the end also breeds slum development.

Table 3: Analysis of socio-economic challenges in the study area.

Variables	N=366	%
Lack of infrastructural development	105	28.6
Inflation in cost of commodities	123	33.7
Escalation of land price	75	20.4
Unaffordable land	19	5.2
Lack of education and social facilities	23	6.3
Land tenure conflicts	9	2.5
Cost of land security	12	3.3

Source: Field survey (2017).

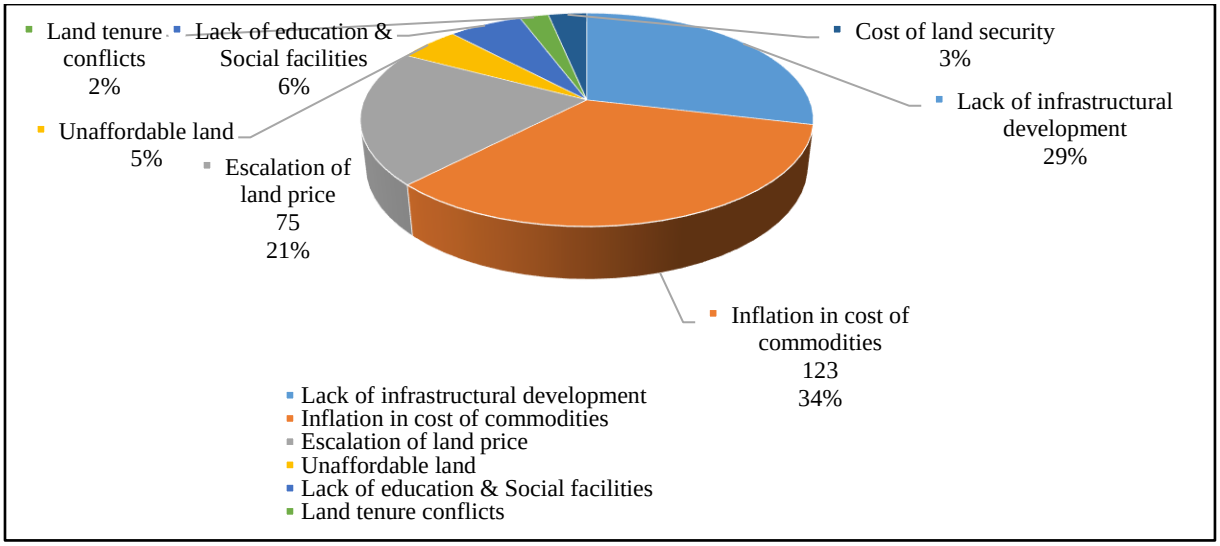

Figure 2: Analysis of socio-economic challenges in Ibeju-Lekki. Source: (Fieldwork, 2017).

Assessment of Institutional Challenges in the Study Area.

Planning in the peri-urban has its challenges both from the residents and the system that created the policies. There are several institutional challenges to planning in Lagos peri-urban but found to be peculiar to Ibeju-lekki through the field survey presented in Table 4 and Figure 3 are landownership problems, huge cost of land regularisation, inadequate land data, and land titling and land speculation.

Land ownership problems constitute 11.7%. Land under excision belonging to the natives lacks detailed data and end up being problematic for those that acquire them for residential purpose. It is common to see different families claiming ownership to same piece of land because of limited land information hence posing to be problematic for the planning officials. The responses of households to regularisation as a result of the high cost attached by the central government also constitute an institutional challenge and ultimately allow informality. This factor contributes 73%. Inadequate land data and land titling problem constitute 6.8% and 6.6% respectively. Land speculation problems constitute 1.9% in the study area.

Table 4: Analysis of Institutional challenges in the study area

Variables	N=366	%
Land ownership problems	43	11.7
Huge cost of land regularisation	267	73
Inadequate land data	25	6.8
Bottleneck in land tilting	24	6.6
Land speculation	7	1.9

Source: Field survey (2017).

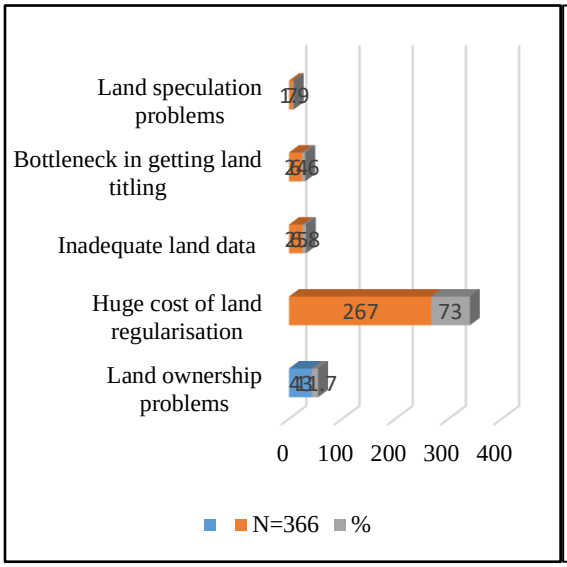

Figure 3: Analysis of institutional challenges

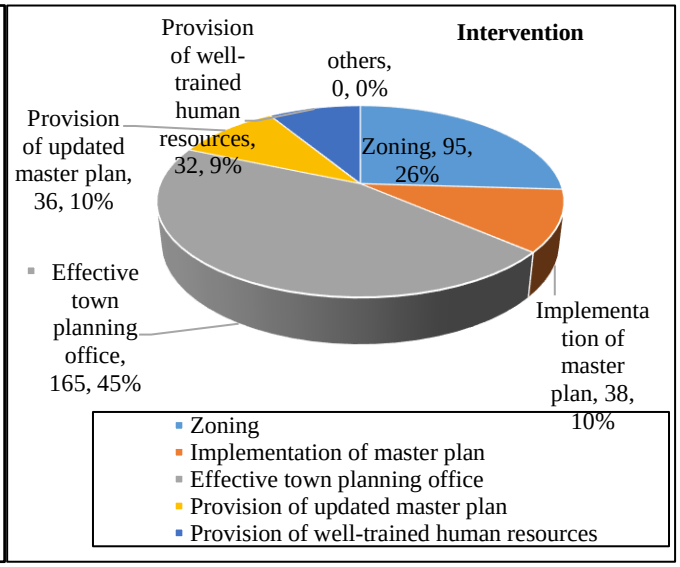

Figure 4: Analysis of intervention strategy

Development in the Study Area

Analysis of the field survey in Table 5, shows that land price dynamics and development tend to increase in the study area. Growth forecast is predicted to appreciate by 98.1% and to depreciate by 1.6% and consistent as indicated by 0.3% of the sampled households.

Table 5: Analysis of development and land price forecast.

Variables	N=366	%
Future growth forecast:		
Appreciate	359	98.1
Depreciate	6	1.6
Consistent trend	1	0.3
Others	0	0
Land price forecast:		
Appreciate	360	98.4
Depreciate	1	0.3
Neutral	5	1.4

Source: Field survey (2017).

Development intervention strategy in the study area

Field work survey using in-depth interviews and questionnaires shows some factors are necessary for an effective development strategy from both residents' perception and governments. Interviewed for this section were government representatives in planning offices, private developers and the community leaders. Analysis of the interview sessions is presented in Table 6 and Figure 4. As shown through the analysis, the strength of zoning as a planning tool is 26%. This implies the strict adherence of spaces in urban development to the earmarked purpose. It was noted through the interview that defaulters to this are both the central government and individuals. It was observed that there was conversion of spaces for purposes contrary to those set out in the master plan. Zoning if well executed is a tool for shaping urban space and for enforcing sustainable cities.

Further shown to be problematic in the planning policies in the study area, is deviation from the master plans. Findings through this field work show that there is no regular update of the master plans in generally at the state level this also translates to regional areas. Lagos. The existing master plan for the Lagos metropolitan region was last updated in the year 2000, showing lapses of sixteen years of uncaptured development in places outside Lagos metropolitan region of which Ibeju-Lekki is one. There is need for a regular update of the master plan to capture the trend and pattern of development. Availability of updated master plan and the implementation according to the analysis of field work response will improve development strategy by 9.8% and 10.4% respectively. Lack of effective town planning office and well trained human resources is also an institutional challenge in the study area. Though Ibeju-Lekki have a make shift mobile planning office, limited services are delivered in such. Analysis of the field survey shows that availability of an effective town planning office and well trained human resources will enhance development strategy by 45.1% and 8.7% respectively.

Table 6: Analysis of intervention tools in the study area.

Variables	N=366	%
Zoning	95	26
Implementation of master plan	38	10.4
Effective town planning office	165	45.1
Updated master plan	36	9.8
Well trained human resources	32	8.7
Others	0	0

Source: Field survey (2017).

CONCLUSION

Urban policy does not come without its own challenges. Three types of challenges exist in the management of the study area namely institutional challenges, environmental challenges and socio-economic challenges. Institutional challenges are created by policy lapses and ineffectiveness and can only be solved by the regional government. Prevailing institutional challenges in the study area are land ownership problems, huge cost of land regularisation, inadequate land data, land titling and land speculation. Environmental challenges are either induced by the natural topography or uncontrolled industrial activities. Noted environmental challenges in the study area are flooding, industrial pollution and traffic congestion. Socio-economic challenges are driven by people and the circumstances surrounding them. Recognised socio-economic challenges are rising cost of commodities as population increase, lack of affordable land and social facilities. It can be deduced that there exists an inter-relationship among the three-tier challenges because most environmental and socio-economic challenges are due to delayed or poor institutional responses to the pattern and pace of development in the study area.

In-depth interview with planning officials and the analysis of the questionnaires show that some measures can be put in place to counter challenges to planning and governance in the study area.

Identified strategic tools for planning are zoning, availability of an updated master plan, and implementation of master plan, effective town planning office and provision of well-trained planning human resources. Findings show that availability of effective town planning offices in the study area is the most considered strategy to an effective management. Informality operates in the absence of effective development control, if planning is to be effective in Lagos peri-urban settlements, there must be a responsive planning and policy framework to the different interest of all actors and stakeholders to control further unsustainable housing development in the study area. With the peripheral areas playing vital role in housing development, it is necessary for regional government to play a strategic role in building a minimally challenged urbanism by developing infrastructure and policy that could guide in managing the spatial growth of the peri-urban settlements in achieving sustainable development.

RECOMMENDATIONS

A policy framework that anticipates the pattern of development to avoid having an unsustainable and environmentally disruptive or impaired development will aid in abating the challenges facing the management of Lagos peri-urban housing development. Planning of housing schemes in the peri-urban should be integrated with other urban land uses for efficient distribution of infrastructural facilities.

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A FRAMEWORK STRUCTURE TO ENHANCE THE IMPLEMENTATION OF PRIVATE FINANCE INITIATIVE (PFI) PROJECTS IN MALAYSIA AT PRE-CONSTRUCTION STAGE: A METHODOLOGICAL DEVELOPMENT

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ABSTRACT

Private finance initiative (PFI) in Malaysia has been inundated by various controversies and criticisms from the very beginning. Yet, in-depth researches relating to them have been lacking. Based on the circumstances, the paper proposes a framework structure to enhance the implementation of PFI projects in Malaysia with focus on the pre-construction stage with the following objectives: to determine the issues and constraint which have arisen, to determine the success factors and lastly to develop a framework for performance improvement. Semi-structure interviews with 35 experts and nine case studies (each three representing Modes 1, 2 and 3) were used to collect data. The study found ten success factors which is: fair risk distribution, public-private cooperation, comprehensive output specification, value for money, maintenance culture, innovation, performance-based payment, cost linked to life span, transparency and financing. A workable implementation framework for the pre-construction stage was developed after industry practitioners tested it. This framework can help industry players including contractors in making sound decisions when undertaking PFI projects.

Keywords: *Private Finance Initiative (PFI), Implementation, and Framework.*

INTRODUCTION

Private Finance Initiative (PFI) is a privatization scheme develops initially by the UK government, to provide financial support for the partnership between the public and private sector. PFI has become an integral part of the national government policy of the UK in the delivery of public facilities and services (HM Treasury, 2003:2006). The PFI scheme has been implemented in many countries around the world and this form of procurement system has been increasingly important over the past decade (Kato, 2001; Endicott, 2001; Beeston, 2002; Imamura, 2002; JETRO, 2003). However, in terms of the implementation process, the PFI arrangements are not similar from country to country (NAO, 2003).

In the Malaysia context, the Ninth Malaysia Plan (9MP) defines PFI as involving the transfer of the responsibility of financing and managing capital investment and services in relation to public sector assets to the private sector (Economic Planning Unit, 2006). The private sector will be responsible for financing, constructing, managing, maintaining and operating the facility to deliver the service to the public sector throughout the concession period. In return, the public sector will pay the private sector in the form of lease rental charges, which commensurate with the quality of the services provided.

The purpose of PFI is to level the close relationship between the government and the private sector, including for the federal government and local authorities. According to Khairuddin (2009), PFI is an alternative to public procurement strategy. PFI refers to the delivery of public services assets that are

previously undertaken by the government and now will use the funding and expertise from the private sector jurisdictions. In Malaysia, the government has adopted the PFI with the aims to ensure the projects that are carried out by the private sector can complete quickly. At the same time, the government implements the concept of capacity to pay first, and also to ensure that social projects such as schools, roads, and hospitals can be conducted and completed by the private sector. It is necessary to achieve value for money and project risk should be borne by both parties. Before the Ninth Malaysia Plan 2005-2010 (9MP), Tun Abdullah had established Pembinaan BLT Sdn. Bhd. in 2005, with the aim to control the development and implementation of construction of quarters and facilities for the Royal Malaysia Police across the country (Khairuddin, 2009). This idea was to see a practical application of this project using PFI approach, which is called build, lease and transfer (BLT). The success of this project will also serve as benchmarks for the implementation of PFI projects under 9MP. In line with the policy to strengthen public-private partnership, the government is actively implementing PFI to stimulate private investment.

The government has identified projects worth RM20 billion, undertaken on BLT approach. Funding obtained from the Employees Provident Fund (EPF) and the Pension Trust Fund (PTF), which will have assets built for rent back to the government. Among the projects that have identified includes schools, quarters, and office buildings. Besides, the PFI Facilitation Fund worth RM5 billion has been injected to support projects identified by the private sector with extensive branching effects on economic growth (UKAS, 2009). Under this method, the private sector will bear the full risk of the project while the government only provides financial support to enhance project viability. Among the supports provided include sponsoring students to private institutions and provision of land and necessary infrastructure. The government also could purchase or lease a new building built by the private sector in the city to ensure the viability of the project (EPU, 2006). There may be confusion in the setting of PFI Sdn Bhd in which Employee Provident Fund (EPF) has injected RM260 billion investments at RM12 billion per annum in the said SPV (Special Purpose Vehicle. According to Tay and Partner (2006), seemingly, PFI is not different from previous privatization models. Both involve the public sector tapping the expertise and efficiency of the private sector. But under PFI, the private sector's revenue must commensurate with the quality of services it provides. Hence, the clear elucidation of accountability as an essential principle in PFI represents a paradigm shift in Malaysia's privatization landscape. Evolution of the PFI in Malaysia is a learning point for a variety of factors to ensure successful PFI in the construction industry (Khairuddin, 2009). Integration between the government and the private sector in carrying out a project has enabled the country to make a profit, typically to improve the construction industry and the economy.

PFI AND THE CHALLENGES

PFI has been a part of the construction industry since early 2005's. However, the building project by using PFI cannot avoid having problems especially when it newly introduced in the industry. By implementing new procurement method, there will be serve consequences when the projects begin due to lack of knowledge vague understanding of the procurements perceptions (Shamsida & Abdul Rashid, 2009, Izatul Laili Jabar et. al, 2015). To make it worst, the PFI implemented in Malaysia is diverse from PFI implemented in the UK. Roshana et. al., (2009) and Shamsida & Abdul Rashid (2009) mentioned that PFI concept adopted in Malaysia doesn't follow the basic criteria of the International PFI framework that had tested in many developed countries such as Australia, UK, and Europe. As a result, local government and private sector will be having a huge problem whenever setbacks arise during the construction due to lack of information regarding how to solve the issues. According to Yong (2004), more than 140 countries around the world are using PFI as a catalyst for the construction industry projects that have not implemented due to lack of financial sourcing and capacity. However, PFI implementation is not same between one country and another (NAO, 2003). Also, according to Kok (2006), the differences regarding politics, economy, social, and law between the countries have also resulted in the lack of a blueprint or plan on how to ensure the successful implementation of PFI projects. Thus, each government should plan their implementation programmed based on their respective suitability and available capacity.

A REVIEW ON PRIVATE FINANCE INITIATIVE (PFI) FRAMEWORK

According to Jean and Gibson (1992), a framework structure needs to possess a variety of equipment or a part of the source of information to ensure that the important things are given due attention. A framework structure is developed based on a set of concepts that connects each of the plans or methods of implementation process, main characteristics, and success factors.

The development of the framework has referred to some previous scholar's framework such as the framework for improving the tendering process (NAO, 2006), accountability and value-for-money evaluation (Demirag et al., 2004), critical success factors (Jefferies et al., 2002, Qiao et al., 2001, Morledge and Owen, 1998, Li et al., 2005), and PFI/PPP projects implementation (Cheung et al., 2007). All the studies do not demonstrate any relation in the issues and constraints along the course of PFI projects implementation, especially at the planning and tendering stage, and the relation between the main criteria to be integrated into the implementation of PFI projects to avoid such issues and constraints.

In the case of Malaysia, the implementation and policy of PFI has been the subject of considerable debate and critiques (Syuhaida, 2009). Some of the reasons as mentioned by Abdul Rashid (2009) and Saidan Khaderi (2011) are leading to the issues of cronyism, unfair monopolistic advantages, lack of transparency in competitive bidding and, lack of PFI experiences and knowledge in PFI. Besides, there are many aspects of this approach that require fine-tuning and improvements to make it more cost effective. Areas related to the improvement of key functional skills in technical aspects, finance, personnel management, and value for money, risk allocation and, public knowledge are important to be highlighted. As such, the need for a comprehensive regulatory framework is a matter of some urgency for PFI in Malaysia (Saidan Khaderi, 2010; Shamsida & Ani Saifuza, 2016). A significant reason for this matter is to further encourage participation from the private sector and to make them feel less restrained to exploit their market power.

The framework structure is developed after undergoing a process of discussion on the results of research findings identified based on the scope and main issues relating to framework structure development to enhance the implementation of PFI projects at the pre-construction stage. The solutions provided by this framework structure include the processes at the planning stage, tendering stage, the main characteristics, success factors and gateway review, all of which must be made available during implementing the PFI projects. These solutions aim to facilitate all industry players especially the contractors in implementing effective PFI projects. The components in the framework structure are as follows:

- The most critical stage of implementation is the pre-construction stage i.e., planning and tendering stages;
- Issues and constraints in planning and tendering stages; and
- The main characteristics and success factors required enhancing the PFI project implementation.

THE METHODOLOGICAL DEVELOPMENT

The Unit of Analysis

The target respondents involved in this study were based on the criteria that they should have the expertise, experience, and knowledge on PFI project and the majority of respondents are those at the top management of an organization. Expertise in this research is referring to people who are exposed to the PFI process and have direct experience in the implementation stage, policy, financing and monitoring as well as experienced in privatization projects before.

Selection of individual as respondents based on the importance of the activities carried out in determining the successful of PFI projects implementation. It is equivalent to Birrell (2002), which

stresses that the characteristics of the respondents also needs to consist of those who have qualifications in decisions and have the experience and expertise in running projects. This is also consistent with Schmidt et. al., (1986), that the importance of experience in controlling the quality gave a high impact and the efficiency of works.

The Process

The literature review indicates key features, concepts, structure, procurement, success factor and criticisms raised in the pre-construction projects of PFI implementation. Among the features of PFI identified from the literature review is a partnership between the government and the private sector, the determination of output specifications, innovation, value for money, risk sharing and optimal focus to service assets on an ongoing basis. Researchers also reviewed the literature regarding the PFI procurement process and structure of PFI for the countries selected because the model of PFI is used is different for each country based on political, economic, social, and legal and the culture of each country.

The development of the framework involved two research methods, namely the Preliminary Survey (Semi-structured interviews) and Main Survey (Case Study and semi-structured interviews). Hence, the components of the framework focused on the outcome of these research methods.

THE METHODOLOGICAL

The Preliminary Survey – Semi-structured interviews

A semi-structured interview was conducted to get the data and information about the implementation of PFI projects in Malaysia in more details. The interview was conducted with respondents who were selected based on expertise, experience, and knowledge in the implementation of PFI projects. The respondents were a senior manager in government agencies, bankers, consultants and contractors in private sector who had been involved in the exercise of PFI projects. The interviews aim is to verify whether the data obtained from the literature review and semi-structured have in common or different.

Semi-structure interviews involving 35 experts from diverse backgrounds based on the criteria that have been set before were used to collect the data. The study found the divergence between Malaysia's PFI implementation and other countries in terms of purpose, financing, management, risk distribution, and maintenance. Seven issues and constraints were identified: unclear output specification and need statement, not transparent, political interference, guideline ambiguity, direct contract award, lack of maintenance application and obscure PFI concept. Ten success factors were identified: fair risk distribution, public-private cooperation, comprehensive output specification, value for money, maintenance culture, innovation, performance-based payment, cost linked to life span, transparency and financing.

The Main Survey – Case Studies

Case studies were conducted to gain more detailed and identify the effective implementation of PFI project at the pre-construction stage. Nine case studies (each three representing Modes 1, 2 and 3) were used to collect the data (refer figure 1).

Semi-structured interviews were conducted and this time takes longer than the first interview because it is based on the accumulation in identifying suitable projects and industry players involved in it. The term of interview period become longer because most respondents too busy and often postpone the interview. A total of 36 respondents were interviewed in the survey information with respect to a project. For each project, four respondents were interviewed and they consist of the client, contractor, and consultant of Architects and Quantity Surveyors. It is intended to get the real scenario of the exercise of a PFI project undertaken.

In reviewing each case for selected project, researchers have determined the character and the major criteria in the implementation of the PFI obtained from the literature review conducted earlier. Next, the questionnaire has been developed based on the most critical stage in the implementation of PFI and the issues and constraints that arise which involves the process of planning and tendering stage.

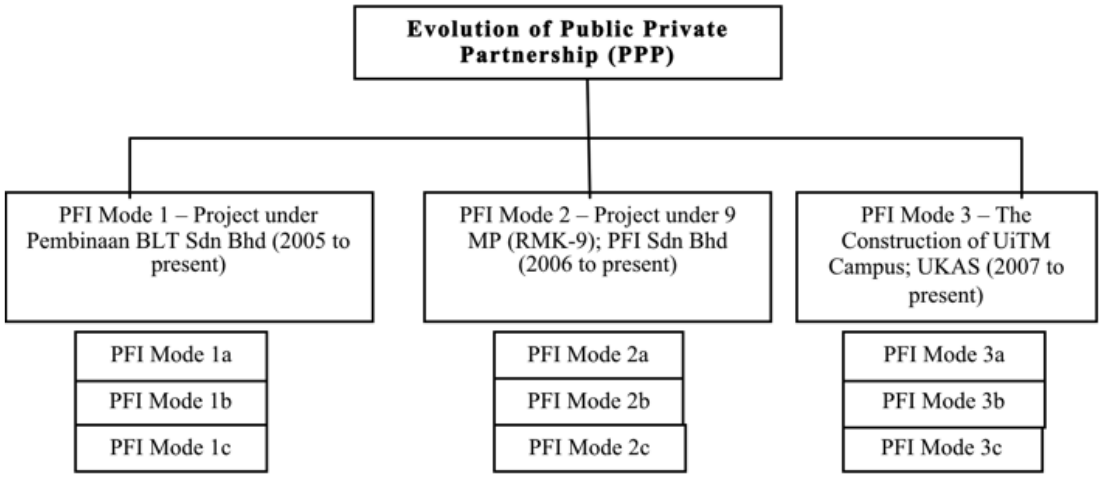

Figure 1: Case studies conducted by researchers

The first stage of the case study methodology suggested by Yin (1994) is to develop a case study protocol. She firmly stated that the rules and procedures contained in the protocol should be developed to improve the reliability of the quality of the case studies are made. While Yin (1994) also added that the preparation of the protocol is suitable for the study using the multiple cases.

The Industry Validation

A workable implementation framework for the pre-construction stage was developed after industry practitioners tested it. This framework can help industry players including contractors in making sound decisions when undertaking PFI projects. Validation of the framework is to identify whether a framework providing the right solution to the problems of the study (Bock, 2001). In other words, it reflects the important aspects that need to be included in the process of implementation of the PFI. The goal of this validation was to obtain feedback from the panel selected that the proposed framework to enhance the implementation of PFI projects. It is intended to ensure that this framework is evaluated on whether they meet the industry player's acceptance.

McGraw-Hill Encyclopedia of Science & Technology (2002) proposed that the ratification of the framework would be achieved and accepted if it is done in an industry that literally has the expertise and engages with these fields based on the face-to-face validation. The developed framework to enhance implementation of PFI project at pre-construction stage was face validated by the panel representing the 3PU (Public, Private Partnership Unit), concessionaires, consultants, the implementing agency and the end-user. These panels are selected based on their experience and involvement in the implementation of PFI projects in Malaysia. The panels were selected from respondents who had previously been involved directly with the semi-structured interviews or case studies. Therefore, data validation framework is achieved when respondents can give a good view based on studies carried out.

RESULTS AND DISCUSSIONS

The main component in the developed framework of PFI implementation is a pre-construction stage. It is due to the existence of various issues and constraints that arise during that period. Issues and constraints that occur during this period have led to the failure of a PFI project undertaken. Therefore, to avoid the continued widespread then all players in the industry are involved in the implementation of PFI projects, particularly in the pre-construction must understand and practice the key features of PFI implementation.

The results findings from the study and literature review show the process integrated into the planning stages, objectives, feasibility studies, outlines business case and project development. While there are processes in the tendering stage, tender invitation, tender prequalification, tender evaluation and contract negotiations until the tender was awarded and signed. According to Jean and Gibson (1992), the framework should have a diversity of equipment or a part of the resources to make sure the important things to note. The structure of the developed framework is based on a set of concepts that connect each design or method of the system of the implementation process, the main characteristics and success factors.

The structure of the framework is developed after undergoing the process of discussion on the findings that have been identified based on the scope and key issues related to the development of a framework to enhance the implementation of PFI projects in pre-construction stage. The structure of the framework developed is intended to highlight the solutions to the problems that occur in the planning and tendering stage. Thus, to understand the process, the framework to enhance the implementation of PFI project in pre-construction stage is illustrated in Figure 2. The phases involved the components of the implementation process, constraints, main characteristic and success factors in planning and tendering stage which was identified and established through the preliminary survey; the main survey and semi-structured interview. It is intended to help all industry players, especially the contractor in implementing effective PFI projects.

The developed framework is to facilitate all industry players involved in PFI projects. The structure of this framework is a continuation of the PFI/PPP guidelines, which has been issued by the Public-Private Partnership Unit (UKAS) in early 2006.

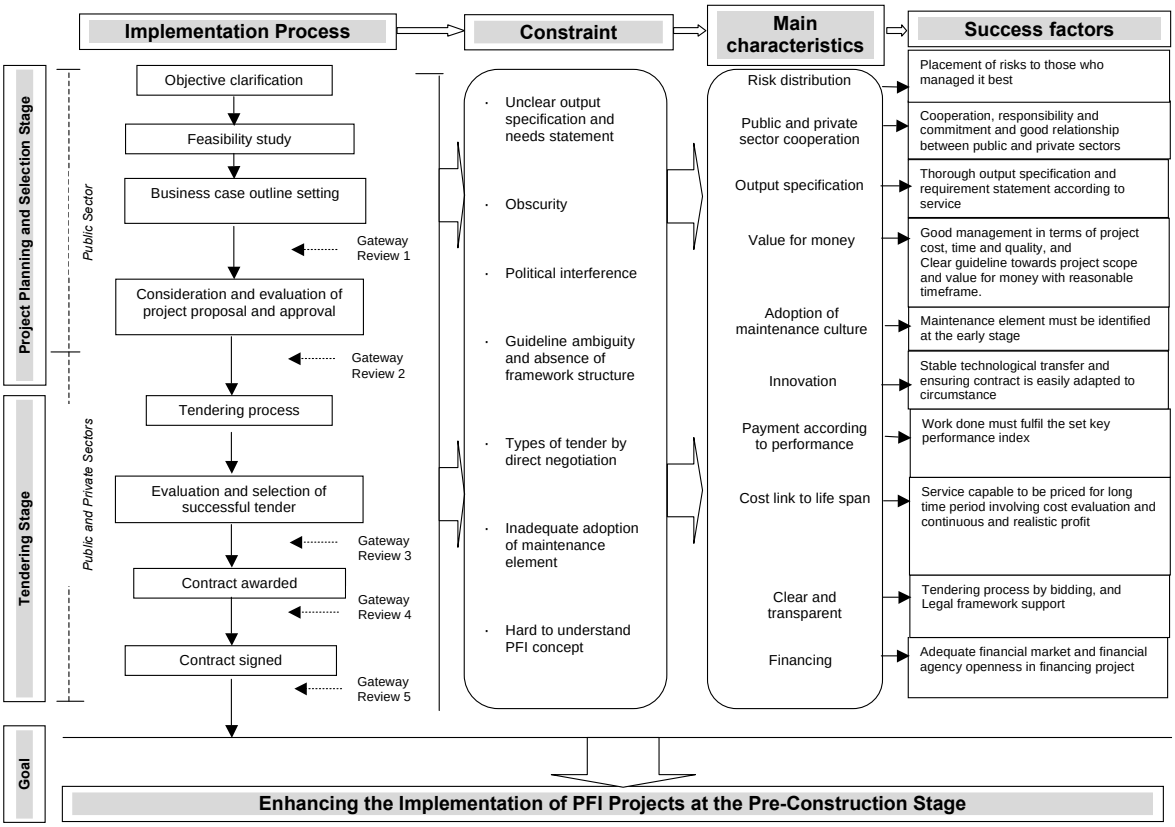

Figure 2: Framework for enhancing the implementation of PFI projects at the pre-construction stage

CONCLUSIONS AND RECOMMENDATIONS

The objective of this paper is to discuss a workable implementation framework for the pre-construction stage and the key issues and challenges of PFI implementation in Malaysia compared to other countries have achieved. Results from the content analysis show that there are differences between Malaysia and other countries regarding PFI implementation. Maintenance is not in the concession agreement and will be under the obligation of liability of any ministry except PFI projects Mode 3, the output specifications, and the needs statement is not clear and tender process conducted by negotiation. However, there are also similarities in the purposes of implementation of PFI projects in Malaysia and other countries. The government does not want to carry a heavy burden in early stages; the government wishes to encourage private sector involvement and investment in public projects, and the government wishes to expand the economy. The advantages of PFI can be fully gained if there is a close collaboration between the government and the private sector. Even there are several issues of PFI are not finalized yet due to its newly introduced concept, the key issues and challenges are addressed through investigation of several aspects. It is believed that the PFI will be a panacea to the shortage of government funds and poor maintenance culture if the PFI executed in more efficient and transparent manner.

The process of framework structure development is a significant contribution to the research findings. Thus, this paper focuses on discussing main phases in a framework that cover rationality of developed framework, the process of framework development, verification from industrial parties, and application of the framework. The framework approach showed that pre-construction stage involving planning and tendering stages is the most critical stage in the implementation of PFI projects. This is because there are a lot of matters and limitations faced during this stage that result in the implementation of PFI projects becoming more complex. Thus, to avoid facing those matters and limitations, every industry player involved in the implementation of PFI projects should apply main features components and each feature explains about success factors. Researchers have identified Gateway Review elements

that should be practiced at planning and tendering stages to ensure the amplification of PFI projects. Qualified and expert panels in the implementation of PFI projects did verification on this framework.

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PRESERVING AND ENHANCING THE CULTURAL LANDSCAPE OF KAMPUNG SANTUBONG, THROUGH ECO-VILLAGE APPROACH

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ABSTRACT

This article attempts to discuss a comprehensive design of landscape conservation for Kampung Santubong, Kuching Sarawak. The purpose study is by preserving and enhancing the cultural landscape of this village through eco-village approach. Major issue of the village is lack sense of personalization, damage of significant building, loss of traditional practice and loss of estuary mangrove ecosystem. As to encounter the issues, this study come out with the aims to revive the memory of Kampung Santubong by preserving and enhancing the local distinctiveness of Kampung Santubong through Eco-village approach. The methodology used in this project is by preparatory study from National Park Service (NPS) Guidelines for evaluating and documenting rural historic landscape and comparative study that reveals several design guidelines. Subsequently, the implications of the analysis and synthesis mapping is used to translate a complementary intervention proposed by the conceptual plan before developing a master plan. Based on this study, the sustainable design approach is used such as reef ball, river treatment, regreening, bio-pores and human and crocodile conflict management. The finding of the project is by preserving all the significant of Kampung Santubong through the identity and history of the village by interpreting the design with a sense of place while achieve balancing vernacular landscape. Hence, this study of cultural heritage village and design program as to sustain the cultural landscape at Kampung Santubong.

Keywords: *Landscape conservation; vernacular; eco-village; sustainable design approach*

INTRODUCTION

This study is focussing on the historic vernacular landscape at Kampung Santubong, Kuching Sarawak. Historic Vernacular Landscape is a landscape that evolved through use by the people whose activities or occupancy shaped that landscape (Taylor, 2002). Through social or cultural attitudes of an individual, family or a community, the landscape reflects the physical, biological, and cultural character of those everyday lives (Agnoletti, 2006). The function plays a significant role in vernacular landscapes. They can be a single property such as a farm or a collection of properties such as a district of historic farms along a river valley. Examples include rural villages, industrial complexes, and agricultural landscapes (NPS,1994).

The Puteri Santubong was known for her weaving skills because she made the most beautiful clothes in the Kayangan. Puteri Sejinjang was known for her rice pounding. All the rice she pounded became the tastiest rice. The King sent Santubong to Pasir Kuning and Puteri Sejinjang was sent to Pasir Putih to bring peace. However, their friendship did not long lasting. But none caught the princesses' hearts until they met Putera Mahkota Serapi. Both princesses felt in love with the prince at the same time and start quarrel. Sejinjang took a pounder and hit Santubong's cheek till it cracks. Santubong hit back using her Belidak, a tool for her to weave clothes. The Belidak hit Sejinjang's head. Because of the heavy and

sharp tool, Sejinjang's head broke into million pieces and scattered in the sea to become small islands (Suai & Jantan 2005).

The king was angry with both of them for fighting over a mere mortal. He cursed them to become Mount Santubong and Mount Sejinjang. The village is located on the hillside of Mount Santubong caused the area called Kampung Santubong. The village of Santubong, located at the mouth of the Santubong River, is small and quiet. The village is located in Kampung Santubong sub-locality, Kuching locality, Bahagian Kuching District, Sarawak which extending from the position Latitude: 1.721921° and Longitude: 110.316741°. It has some superb natural attractions centred on the rainforested slopes of Mount Santubong, its mangrove forests, rivers, near shore waters and mudflats. Kampung Santubong, a well-kept Malay village at the foot of Mount Santubong, is an interesting coastal villages (kampungs) in the Santubong Peninsula (Baring-Gould, 2014).

RESEARCH AREA

This study highlights on the key words which are preserving, enhancement, cultural landscape. The term Preservation is defined as the act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. (Leach & Wilson, 2014).

New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project (NPS,1994). Based on the National Planning Policy Framework (2012), Enhancement is the process of managing change to a significant place in its setting in ways that will best sustain its heritage values, while recognising opportunities to reveal or reinforce this values for present and future generations.

According to National Park Service (1994), a cultural landscape is defined as "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values." There are four general types of cultural landscapes, not mutually exclusive: historic sites, historic designed landscapes, historic vernacular landscapes, and ethnographic landscapes.

The aim of this paper is to revive the memory of Kampung Santubong by preserving and enhancing the local distinctiveness of Kampung Santubong through Eco-village approach. To support this aim, there are three (3) objectives which are to conserve and improve the functional and structural style of vernacular physical built form through planning and design treatment. Second objective is to enhance the quality of natural environment which rehabilitate the natural setting of village uses sustainable planning and treatment, to protect the richness of biodiversity inside existing surrounding ecosystem. The third objective is to promote sustainable society through healthy lifestyle cultural activities, social economic within Kampung Santubong and increasing the interest and participant of local activities through cultural tradition.

PROBLEM STATEMENT

The problems that have been identified in this village is derived from 3 perspectives which are built form, environmental quality, socio-economic problems. These problems have impacts towards the livelihood of the villagers in Kampung Santubong. The existing cultural landscape of the village is highly depending on environment, cultural and also economic aspects. Uniqueness of every civilization that they have something they can be proud of. It is called Genius Loci that strengthen the community surround that makes it different from others. Lack of personalization loses speciality and loss identity of certain place or community just like major village in Malaysia (Peterson et al. 2010). It is important

the place must have significant buildings. Buildings can be landmark, pin pointing, or historical facts to greet the past as a mark of how the community been built. Vanishing of house compound and historic buildings make the real community and surrounding of past cannot be identified.

The reason of losing the traditional practice is because the young generation did not have an interest to inherits the traditions from their ancestors. Young generation likely migrates and likes modern life at the city nearby that offers various occupation and salary. In addition, soil erosion makes their local activities disturbed and reduce their source of daily income. (Douglas & Douglas, (1999), Riguccio, et al (2015)). The threat focuses on the natural environment that is slowly degrading due to the poor waste management around the fisherman village and critical of coastal erosion. The human activities also have been affected the river ecosystem, and threating the vernacular landscape of the village. The unsanitary condition of fisherman village can attract the predator to come and disturb their area. It has become a major problem to the overall sustainability of the ecological balance (Samah et al. 2011).

METHODOLOGY

A comparative study was conducted between case and reference studies base on the identified domains in literature study: i. site location and context; ii. conceptual development; iii. design goal and objectives; iv. concept and design programming; v. cultural activities through master plan; and vi. design components. The chosen sites were located in Malaysia base on cultural activity's establishment and successful design interpretation (Boon, 1982).

The comparative study resulted domains to be considered during the inventory and analysis stages in Kampung Santubong, Kuching Sarawak (Schaich, Bieling et al. 2010). In accordance to National Park Service (1984), there are 11 characteristics has been developed for reading a vernacular landscape and for understanding the natural and cultural forces that have shaped it. Landscape characteristics are the tangible evidence of the activities and habits of the people who occupied, developed, used, and shaped the land to serve human needs; they may reflect the beliefs, attitudes, traditions, and values of these people (Burgi et al. 2013).

Based on 11 characteristics of the rural landscape, there have been identity that 10 of the characteristics can be applied in evaluating the characteristic of Kampung Santubong, Kuching Sarawak. The characteristics are: i. Land use; ii. Land activities; iii. Cultural tradition; iv. Response to natural environment; v. Circulation networks; vi. boundary demarcation; vii. Vegetation related to land use; viii. Pattern of spatial organization; ix. Buildings, structures and x. small scale elements.

For primary data, a site observation and field study has been conducted at Kampung Santubong. All data has been compile as an existing condition through site observation use 10 of landscape characteristics (NPS). Afterward, an evaluation stage such as defining significant, assess historic integrity and select boundaries had been done for the next treatment stage. The treatment stage is by specify stewardship of preservation, rehabilitation, restoration or reconstruction.

Afterward, for the last stage is conceptual and design development. In this stage consists of conceptual development, concept and design programming, master plan development, enlargement plan area, supportive details, and design detail.

RESEARCH OUTCOME AND DISCUSSION

This study focuses in Santubong Peninsula, Kuching Sarawak which is located at Kampung Santubong. The purpose of this study to revive the memory of Kampung Santubong by preserving and enhancing the local distinctiveness of Kampung Santubong through Eco-village approach. Data is collected mainly through site inventory and analysis. It includes the study area, a collection of images of human level and background of sight. Then gathered data transferred in organized manner where the information presented as structured data. From the field observation, there are few major concerns found throughout opportunity and threat analysis: An understanding of significance is paramount. It is necessary. First to determine whether a rural property meets the National Register criteria, and second is to guide decisions about the aspect of historic integrity. So, for a rural property meets or possessed National Register, it at least one NR Criteria (Criteria A, B, C and D) and NR Criteria Consideration (A, B, C, D, E, F and G).

National Register Criteria

Criteria A: Association with events and activities Since 16 centuries, the events and activities interaction of fisherman at estuary of Santubong River and along Tekoyong River simultaneous with settlement existence. Kampung Santubong settlement that monopolies by Malay-Melanau and surrounding by natural landscape retain in term of historical, cultural and natural elements here. Criteria A established the strongest evindence for the establishment of a rural village landscape.

Criteria B: Association with the lives of persons significant in our past.

a) Sultan Tengah/Sultan Ibrahim Ali Omar Shah Reliable that Sultan Tengah settle at this village during his journey back to Kuching from Matan. His royal tomb can be seen until today and located at the main entrance of Kampung Santubong.
b) Rajah Puteh/James Brooke James brooke who founded and ruled the Kingdom of Sarawak. His lodge that located at the high ground of Brooke Hill in Kampung Santubong nearby Santubong River.

Criteria C: Distinctive Physical Characteristic of Design Construction and Form. Kampung Santubong is locally significant example of malay vernacular built form and it can be seen by their original design nation until today. This physical characteristic is important because it is a main contribution to the sense of place of Kampung Santubong. The design of the house we can see through the pillar, elevated boardwalk, roof, material construction and its surrounding by nature features.

National Register Criteria Consideration

National Register Criteria Consideration require some rural properties to meet additional standards. These include properties owned by fisherman settlement, nature features, activities, ordinarily cemeteries, graves of historical figures, reconstructed historic building, and properties that have achieved significance within the past 50 years will qualify as a consideration criterion in Kampung Santubong.

Quality of Integrity

The overriding presence of the settlement, natural features and activities and the seven qualities called for in the National Register criteria are applied to rural village landscape in special ways. Kampung Santubong remains as the rural landscape village because the location, setting, material and overall feeling are intake. The rest of consideration and dramatic loss during the development nowadays. The evaluation of the element of this site by NR Criterion Consideration present strong evidence that this site can be categorized as a rural village landscape.

Master Plan Development

All the information gathered in a series of mapping in conceptual plan using over layering techniques that resulted the design rationalization or synthesis. There are divided into 2 spatial during mapping programming as the aspect categorized by Spatial 1; Fishing village which is more focussing on preservation treatment. The Spatial 2 is at Brooke's Hill and its vicinity which more focussing on rehabilitation treatment (Figure 1).

a) Spatial 1: Traditional fisherman settlement near Tekoyong River. The river as the major character defining features of Kampung Santubong. The traditional livelihood of the village depends on the river and mangrove swamps. Aligned with the current situation, injecting the sustainable design approach with; creating active space, propose market- place and provide protection along the riverbank can revitalize this area.

b) Spatial 2: Wallace Point – A centre of researchers and Scientists. Sarawak Minister of Tourism announced an initiative to revisit the State's tourism master plan, he recalled the project to establish a "Wallace Centre" in Santubong, based on a rehabilitation of ex-Government rest house.

Figure 1: Proposed Master Plan for Kampung Santubong

Most of the house in fishing village area are built of a special kind of woods, which make them resistant to the influence of seawater (Figure 1). The local used to live mainly of fishing. Tourist are welcome and free to stroll about the wooden piers. Hence, they can get a read of sense of everyday life that is far removed from the town.

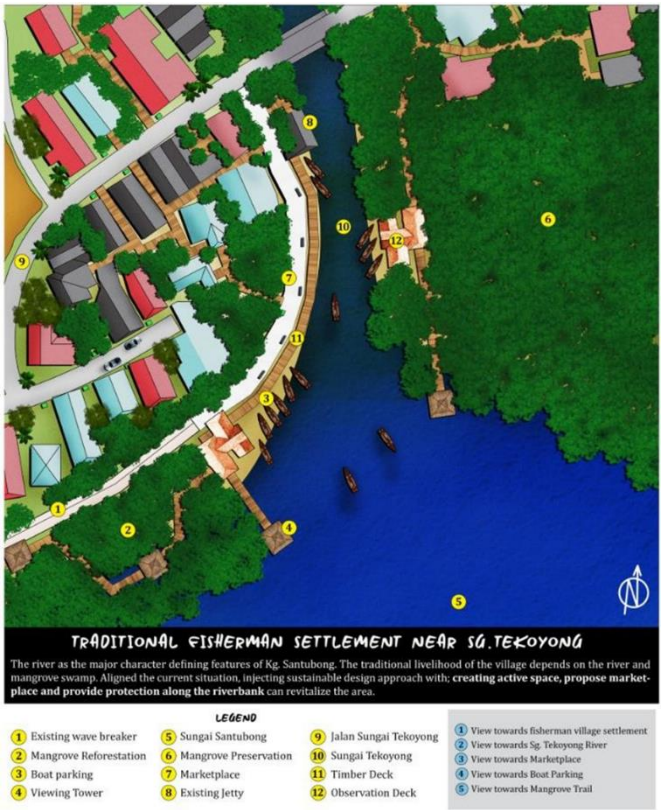

Figure 2: Traditional fisherman settlement near Tekoyong River

Living Historic Tourist Attraction and Homestay. Along the Jalan Sungai Tekoyong and fishing village area, there are variety types of native plants planted and potted that create sense of welcoming and beautification for the village (Figure 2).

CONCLUSION

It is clear that the cultural landscape in Kampung Santubong extinction and required cultural treatment such as preservation, and rehabilitation. This project was a 'protection by development', meaning that in order to survive, heritage landscape should adapt to changing circumstances. Development of Kampung Santubong as a cultural village has few preservations at significant area that have to secure as valuable tangible tradition resources, such as Malay traditional fishing houses. ‘Eco-village of Kampung Santubong’ imply that rural cultural landscape is the first thing that comes to the mind when people think about heritage. The values of rural cultural landscape are varied because it depends on what people looking into. By exploring the idea of Kampung Santubong development, to gain a first impression of the types of rural landscape that might have heritage values at national scale. Hence, revitalization and landscape conservation of Kampung Santubong Cultural Fishing Village need to be protect to interpret the site concurrently for recent development direction of the village. The richness of the cultural and natural biodiversity of the village have a big potentiality as an economic source as to prolong the occupation of the villager.

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SENSITIVITY ANALYSIS OF SAFETY PERFORMANCE OF INDIAN CONSTRUCTION ORGANIZATIONS

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ABSTRACT

Rapid growth of construction activity coupled with utilization of versatile construction equipment has resulted in complex occupational health and safety issues in Indian construction sector. The construction scenario in India is more complicated and governs to exposure to various hazards compared to other industries and it is essential to execute valid approaches of hazard control measures for improving safety performance of construction organizations. The main purpose of the study is to develop suitable construct to benchmark the safety performance in Indian construction organizations. Data envelopment analysis (DEA), being a robust tool, has been employed to evaluate the performance of industries. DEA, basically, takes into account the input and output components of a decision making unit (DMU), to calculate technical efficiency (TE). TE is treated as an indicator for safety performance of DMUs and comparison has been made among them. Fifty Indian construction organizations under ten construction segments including both real estate and infrastructure categories are chosen for comparison purpose. The analysis was conducted by considering two cases; with and without first aid cases in the total number of accidents. Data envelopment analysis was adopted under constant return scale model. The mean efficiency scores of basic and special case are 0.63, 0.75 and 0.77, 0.83 respectively. It is observed that all the efficient organizations are from infrastructure segment only. It has been observed that safety performance of construction organizations under real estate sector is consistently low as compared to infrastructure sector. The number of first aid cases in total number of accidents is influencing the technical efficiency scores of construction organizations.

Keywords: *Data envelopment analysis, constant return to scale, technical efficiency*

INTRODUCTION

Unlike in manufacturing and other industries, implementing safety measures in construction industry is dynamic and accident prevention controls needs reinforcement at every stage of construction. The progress of work changes on hourly basis and safety systems needs to be strengthened in the changing work place conditions (Jayakrishnan, Thomas, Bhaskara Rao, & George, 2013). Any slackness in adapting to the changing construction scenario results into accidents and further worsens safety performance. The significance of construction industry to the economic and social life of India is noteworthy, though it is treated as hazardous. In India, traditionally construction safety performance is assessed based on workplace conditions, analyzing accident statistics, while there is no provision to consider the safety management systems which affect site safety (Devendra Kumar, & Jha, 2015). The construction industry requires an appropriate mechanism to assess safety practices at organizational level instead of implementing prevention approaches based on the reactive data. The efforts of Indian government to enforce occupational health and safety regulations have no marked impact on the safety performance (Kanchana, Sivaprakash & Joseph, 2015).

Information pertaining to safety performance indicators is quite useful to execute proactive safety measures. Data pertaining to safety is a filtering mechanism through which the actual safety scenario is known. In India, safety performance is analyzed based on different safety indices; frequency, severity and incident rates (IS: 3786, 1983). It is not practicable to take decisions or to implement safety strategies on the basis of safety indices. A comprehensive standard was developed in India in 1983 regarding method for computation of frequency and severity rates for injuries and classification of accidents. There is an ambiguity in drawing conclusions from the results of safety indices as no single indices will provide factual position of safety performance but still it is being followed (Mistry, 2008). The reason being a serious accident has a considerable effect on the severity rate but it is does not greatly affect the frequency rate. Many accidents and property damage may not cause the man-days lost are not considered in calculation of safety indices. Severity rate does not represent the actual pain and suffering of a worker. Low frequency rate does mean that severity rate is low. It is also not a healthy practice to compare two or more construction organizations based on the safety indices as type of hazards and working conditions vary across organizations. Practically the safety indices are the partial indicators of injuries and it is difficult to gauge overall safety performance (Mistry, 2008).

To ascertain performance in various construction organizations involved in execution of different works and to identify efficient organization, the input and output parameters influencing safety performance were considered. Several studies were conducted in the past by considering safety expenditure and type of accidents as inputs and outputs respectively to measure efficiency of organizations but ignored cost of accident damages (El- Mashaleh. Al-Smad, Hyari & Rababeh, 2010; Beriha, Patnaik & Mahapatra, 2011). In the present study, the safety performance of construction organizations was analyzed by using data envelopment analysis to calculate technical efficiency. The inputs considered are expenditure incurred towards purchase of safety equipment, for organizing safety training to employees, welfare and health measures. The outputs are total number of accidents applicable as per legislation, man days lost due to an accident and cost of accident damages to the organization. Finally, the benchmarking units are identified basing on efficiency scores.

LITERATURE REVIEW

Construction industry accounts for improving national economy and its contribution is approximately 10% of the global GDP (Chockaligam, & Sornakumar, 2012). In countries like South Africa and Botswana, construction sector contributes 5% and 7% towards national GDP (Murie, 2007). The accident trends show higher rate of accidents in construction industry mainly due to non-existence of safety policy, safe operating procedures, safety awareness among employees and role of site management (Evelyn, Ling, & Weng, 2005). From previous studies, it is revealed that inadequate safety training, ignoring inspections and compliance of PPE are the reasons for poor OHS performance in Jordanian construction industry (El- Mashaleh. Al-Smad, Hyari & Rababeh, 2010).

The results of a study conducted in Chilean construction organizations confirm the strong the association between safety practices and injury rate. Orientation and training, planning and participative practices will improve safety performance at organization level (Carlos, Lusi, & Diethelm, 2007). The construction industry in Europe was utilizing the services of about 7.5% of the total labour and the percentage of fatal accidents is 22.5. In developed countries the accident causation is primarily due to unsafe behaviour of workers (Tiwary, & Gangopadhay, 2011). In Indian context, the low performance is mainly owing to the fact that construction works are temporary, target oriented and failure to enforce legislation (Berger, 2000). Since construction activities are multifaceted and exigent, improving safety performance has become a critical issue and its demand has been proven in studies conducted by the researchers (Small Man, & John, 2001).

Organizing safety awareness programmes for new workers, issue of safety equipment, services of qualified safety officer and regular site safety inspections substantially enhance performance (Koehn, Kothari, & Chih-Shing, 1995).Though there is marginal improvement of safety, the construction industry continues to be hazardous due to maximum number of fatalities (Somik, & Deborak,2009).The strategies adopted towards OHS in developed countries mainly focus on enforcement of legislation and

familiarity with risk assessment (Shibani, Saidani, & Alhajeri, 2013). A study conducted in Indian construction industry reveals that management commitment is vital besides completing the project on time (Tabish, & Jha, 2015). Role of management, labour relations, safety policy and establishing safety management systems affect safety performance (Yung, 2009). Analysis of accident metrics is not useful in evaluation of safety performance as there is every possibility of under reporting of accident information (Lingard, Wakefield, & Cashin, 2011; Dingsdag, Biggs, & Shehan, 2008; Mohammed, 2003; Beriha, Patnaik, Mahapatra, & Padhee, 2012). Sustaining safety is the need of the hour and can be accomplished through prioritization. The previous studies mainly concentrated on analyzing the accident causation (Chockaligam, & Sornakumar, 2012).

Due to non-availability of data relating to safety performance in developing countries has become deterrent to establish stringent safety measures (Chiocha, Smallwood, & Emuze, 2011). The concept of leading safety parameters came into existence due to limitations of reactive data measure safety performance (Reiman, & Pietikainen, 2012; Hinze, Thurman & Wehle, 2013). The gap in the literature has given enough confidence to develop suitable construct to benchmark the safety performance and analyse the effect of first aid cases in total number of accidents in Indian construction organizations.

CATEGORIZATION OF INDIAN CONSTRUCTION INDUASTRY

The Indian construction industry is broadly categorized into real estate and infrastructure segments. The categorization of segments is depicted in Fig.1(NSDC, 2012). The infrastructure segment is a key driver of the growth of the construction industry. Real estate segments comprise residential buildings, commercial and special economic zones while the infrastructure segment includes power, irrigation, urban infrastructure, roads, railways, ports and airports. The risks associated with construction activities in segments differ and complete mechanization is required in case execution of infrastructure projects like underground metro, tunnelling in hydro power projects, roads and railways.

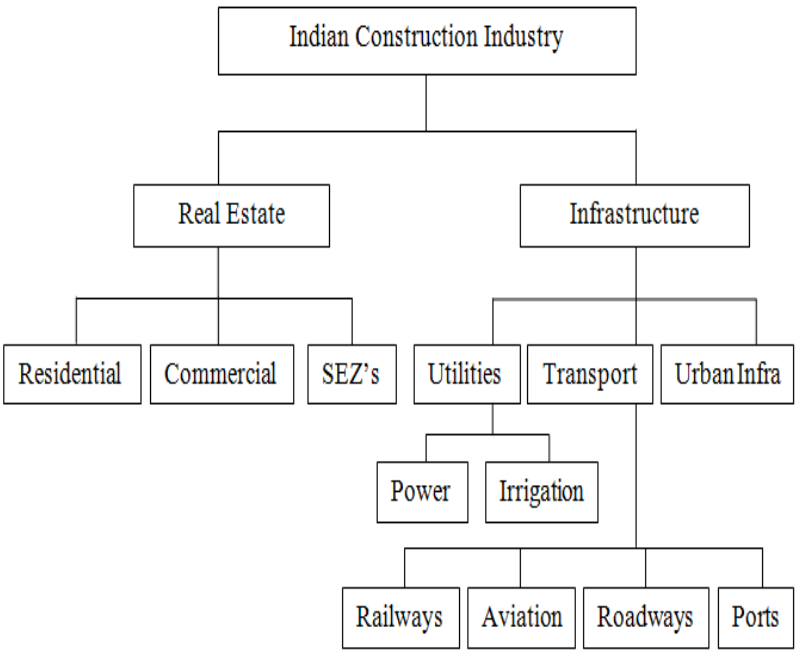

Figure 1: Classification of construction segments

Real estate segment

Real estate segment is one of the largest and fast growing activities in India at an annual growth rate of 10 per cent. The anticipated growth rate will be approximately 19 per cent by 2022. The contribution to the national GDP is 4.8 per cent in 2012-13. Shortage of housing, construction of new office buildings, shopping malls, medical infrastructure and rise in income levels are the factors responsible for rapid development real estate segment (Kaja, 2015).

Infrastructure segment

The share of infrastructure segment is approximately 40 per cent of the construction industry and expected to attain 4774 billion rupees by 2017. Infrastructure segment is cruising ahead of other segments with on hand public partnership projects, construction of irrigation projects, up gradation of existing road network, metro rail construction in major cities, urban housing and construction of power plants. Massive infrastructure development will be seen in near future and consistent safety performance is one of the performance indicators at the project level (Toor, & Ogunlana, 2010; Luu, Kim, & Huynh, 2008).

METHODOLOGY

Data Envelopment Analysis (DEA) is a mathematical programming technique that has found a number of practical applications for measuring the performance of similar units, such as a set of financial institutions, transport organizations, industrial organizations and so on. Data envelopment analysis is a methodology based upon the application of linear programming. It was originally developed for performance measurement and successfully employed for assessing the relative performance of a set of firms that use a variety of identical inputs to produce a variety of identical outputs.

DEA has been applied in various fields of research. To determine labour productivity in construction industries in Europe (Joanicjusz, & Ewa,2015), to compute the efficiency of environment, health and safety performance of contractors in oil and gas industry (Abbaspour, Hosseinzadehlotfi, Karbassi, Roayaei,& Nikoomaram, 2009), applied to assess safety performance in coal mines(Lei,& Ri-jia, 2008), to examine safety performance of 15 European countries in four economic sectors – manufacturing, construction, trades and transportation(Eugenia, & Agnese, 2011), to rank on time completion construction projects (Mazyar, Mohammadreza, Shahrzad, & Hamidreza, 2014), to benchmark safety performance of construction contractors(El.Mashaleh. Shaher, & Khalied, 2010), to measure technical efficiency of 44 state road transport undertakings (Venkatesh, 2006), to benchmark safety performance in construction, steel and refractory industries in India(Beriha, Patnaik,& Mahapatra, 2011), to measure performance of departments of a University in Turkey(Yilmaz, Onur,& Bilge, 2015), to develop a model for computing relative efficiency of banks in Nepal(Karan, & Shashank, 2013), to appraise effectiveness of research and development centres of Czech manufacturing industry(Marie, & Nina, 2013) and to evaluate operational performance of solar cell industry in Taiwan(Hao-En, &Jie –Yi, 2012). DEA, basically, takes into account the input and output components of a decision making unit (DMU), to calculate technical efficiency (TE). TE is treated as an indicator for safety performance of DMUs and comparison has been made among them. Basing on the literature on applications of DEA, it has instilled copious confidence to apply the methodology in the present study.

Mathematical formulation of DEA

DEA is a mathematical programming technique. DEA is a useful tool in measuring the relative performance of group of organizations or departments commonly designated as decision-making units (DMUs). The inputs are transformed into outputs in a decision making unit whose performance is measured. DEA is a linear programming based tool for measuring the relative efficiency of each unit in asset of comparable organizational units using theoretical optimal performance for each organization.

DEA makes use of fractional programming problem and corresponding linear programming problem together with their duals to measure relative performance of DMUs (Charnes, Cooper, Golany, Seiford & Stutz, 1985; Charnes, Cooper, Lewin, & Seiford, 1994). The Charnes, Cooper and Rhodes (CCR) model is a fractional programming problem model that measures the efficiency of DMUs by calculating the ratio of weighted sum of its outputs to the weighted sum of its inputs. DEA also determines the level and amount of inefficiency for each of the inputs and outputs and the magnitude of inefficiency of the DMUs is determined by measuring the radial distance from the inefficient unit to the efficient one.

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Constant returns to scale model

Let there be ‘p’ DMUs whose efficiencies have to be compared. Let us take one of the DMUs, say the qth DMU, and maximize its efficiency according to the formula as shown in Equation 1. Here the qth DMU is the reference DMU. The mathematical program is,

$$\text{Max } G_q = \sum_{a}^{A} c_{aq}\, d_{aq} \;/\; \sum_{b}^{B} e_{bq}\, f_{bq}$$

Subjected to,

$$0 \le \sum_{a}^{A} c_{aq} d_{ap} \;/\; \sum_{b}^{B} e_{bq}\, f_{bp} \le 1;\; p = 1, 2 \;\ldots\ldots P \qquad (1)$$

$c_{aq}\, e_{bq} \ge 0$; b = 1,2, ...B, a = 1, 2 ... A

Where,

G_q is the measure of efficiency of qth unit.
d_{aq} is a^{th} output of qth DMU
c_{aq} is the weight of output
f_{bq} is b^{th} input of qth DMU
e_{bq} is the weight of input
d_{ap} is the ath output of ath DMU
f_{bp} is the bth input of ath DMU

The fractional programme shown in Equation 1 is converted into linear programming problem as shown in Equation 2.

$$\text{Max } G_q = \sum_{a}^{A} c_{aq}\, d_{aq}$$

Subjected to,

$$\sum_{b}^{B} e_{bq} f_{bq} = 1$$

$$\sum_{a}^{A} c_{aq} d_{ap} - \sum_{b}^{B} e_{bq} f_{bp} \leq 0; \; p = 1, 2 \ldots\ldots P \qquad (2)$$

$b = 1, 2 \ldots B, \; a = 1, 2 \ldots A$

The model is called CCR output-oriented maximization DEA model. The efficiency score of 'p' DMUs is obtained by running the above LPP 'p' times.

Selection of construction organizations

In order to identify decision-making units, fifty Indian construction organizations from two segments, i.e. infrastructure and real estate have been considered. Five organizations under each category, where DMUs (RE1 to RE5, C01 to CO5 & SEZ1 to SEZ 5) represent real estate segment and (POW1 to POW5, IRR1 to IRR5, UI1 to UI5, RAI1to RAI5, CA1 to CA5, ROA1 to ROA5 & POR1 to POR5) represent infrastructure segment have been considered and the details are shown in Table 1.

Table 1: Representation of DMUs

DMUs	Segment	Division	Organizations
DMU 1 to 5	Real estate	Residential	RE 1 to 5
DMU 6 to 10	Real estate	Commercial	CO 1 to 5
DMU 11 to 15	Real estate	SEZs	SEZ 1 to 5
DMU 16 to 20	Infrastructure	Utilities /Power	POW1 to 5
DMU 21 to 25	Infrastructure	Utilities /Irrigation	IRR 1 to 5
DMU 26 to 30	Infrastructure	Urban Infrastructure	UI 1 to 5
DMU 31 to 35	Infrastructure	Transportation/ Railways	RAI 1 to 5
DMU 36 to 40	Infrastructure	Transportation/ Civil Aviation	CA 1 to 5
DMU 41 to 45	Infrastructure	Transportation/ Roadways	ROA 1 to 5
DMU 46 to 50	Infrastructure	Transportation/ Ports	POR 1 to 5

INPUTS AND OUTPUTS

DEA considers a DMU as the entity responsible for converting inputs (resources, money etc.) into outputs (performance measures etc.). The inputs and outputs to evaluate safety performance are depicted in Fig. 2. The input parameters have been identified through discussions with the safety professionals, safety managers and corporate safety heads from various construction organizations in India. The safety performance of a construction segment is affected by the total expenditure on safety activities as a percentage of total project cost. The expenditure includes annual cost of safety trainings, promotional activities, purchase of safety equipment & tools and health & welfare facilities provided.

Construction workers in India are exposed to various types of hazards resulting into more than one type of accidents is unlikely to occur at the same time. The Building and other construction workers Act, 1996 is the legislation applicable towards safety, health and welfare of construction workers in India. According to, the building and other construction workers Act, 1996 and rules framed subsequently under this act, the workplace accidents are classified into, first aid cases, accident disables a worker from working for a period of 48 hrs or more immediately following the accident, accident causing disablement subsequently results in death of a worker and dangerous occurrence, whether or not any death/disablement is caused to a worker (GOI, 1996).

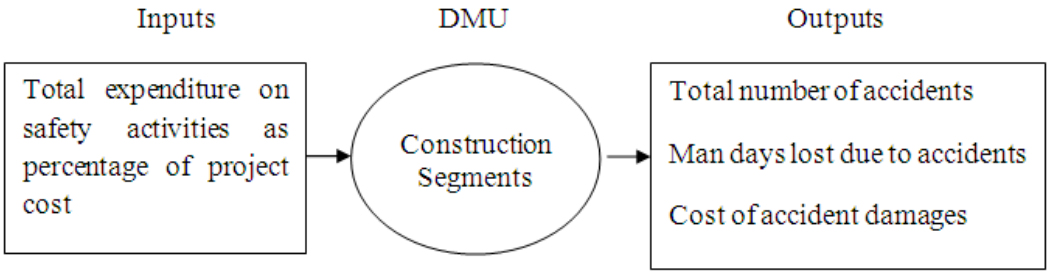


Figure 2: Inputs and outputs

The output parameters considered for analysis are total number of accidents, man days lost due an accident and cost of accident damages. Previous studies on safety performance measurement in various organizations mainly considered number of different types of accidents but not the cost of accident damages. Unlike safety indices which represent safety performance partially, the analysis in the study utilizes the data pertaining to accidents, man-days lost and cost of damages as outputs. Before analysis, all the data require normalization, since the outputs are negative nature and the values are converted into the inverse format and normalized.

Data collection

The data was collected directly approaching the safety managers or safety officers of the organizations and explained about the purpose of the study. Many of them are reluctant to furnish the information about input/ output parameters. Some organizations took written assurance from the scholar to keep the data collected as confidential. Some organizations did not maintain safety records and such organizations were not considered under the study. The data was collected from the year 2013-14 to 2015-16. Majority of the organizations were certified under occupational health safety assessment series (OHSAS) 18001 and the clients are being Government undertakings. The data collection was restricted to five organizations under each category, mainly due to non-availability of data and few organizations reluctant to furnish the details. The normalized data of input and outputs for the 50 construction organizations was shown in Fig. 3 to Fig. 6. DEAOS software has been used to solve the model.

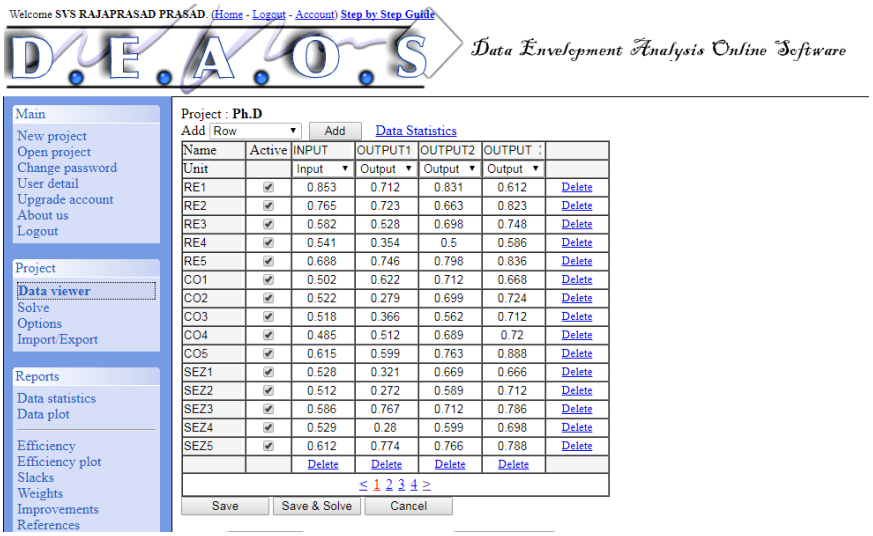
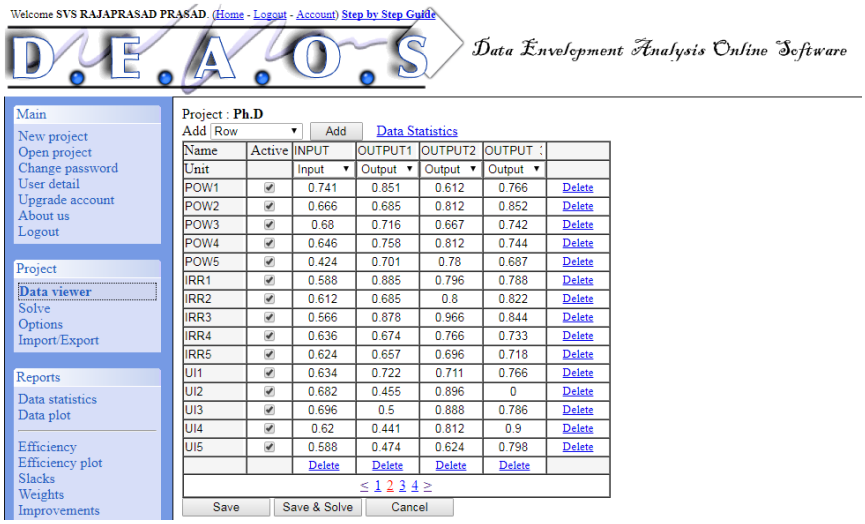
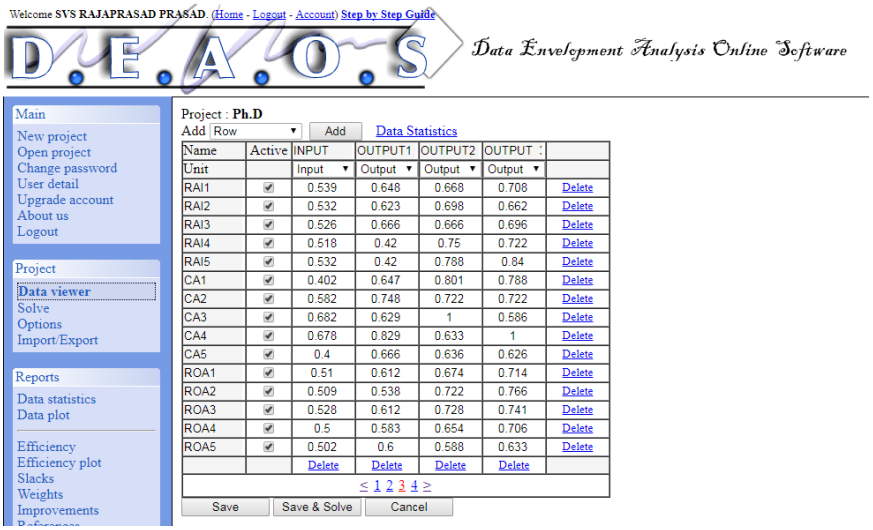


Figure 3: Normalized data of organizations RE 1to SEZ 5



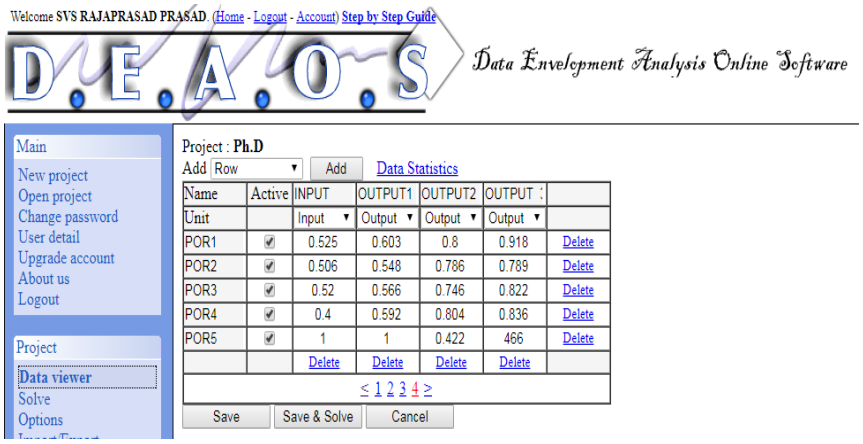
Name	Active	INPUT	OUTPUT1	OUTPUT2	OUTPUT 3	
Unit		Input	Output	Output	Output	
POW1	✓	0.741	0.851	0.612	0.766	Delete
POW2	✓	0.666	0.685	0.812	0.852	Delete
POW3	✓	0.68	0.716	0.667	0.742	Delete
POW4	✓	0.646	0.758	0.812	0.744	Delete
POW5	✓	0.424	0.701	0.78	0.687	Delete
IRR1	✓	0.588	0.885	0.796	0.788	Delete
IRR2	✓	0.612	0.685	0.8	0.822	Delete
IRR3	✓	0.566	0.878	0.966	0.844	Delete
IRR4	✓	0.636	0.674	0.766	0.733	Delete
IRR5	✓	0.624	0.657	0.696	0.718	Delete
UI1	✓	0.634	0.722	0.711	0.766	Delete
UI2	✓	0.682	0.455	0.896	0	Delete
UI3	✓	0.696	0.5	0.888	0.786	Delete
UI4	✓	0.62	0.441	0.812	0.9	Delete
UI5	✓	0.588	0.474	0.624	0.798	Delete
		Delete	Delete	Delete	Delete	

Figure 4: Normalized data of organizations POW 1to UI 5



Name	Active	INPUT	OUTPUT1	OUTPUT2	OUTPUT 3	
Unit		Input	Output	Output	Output	
RAI1	✓	0.539	0.648	0.668	0.708	Delete
RAI2	✓	0.532	0.623	0.698	0.662	Delete
RAI3	✓	0.526	0.666	0.666	0.696	Delete
RAI4	✓	0.518	0.42	0.75	0.722	Delete
RAI5	✓	0.532	0.42	0.788	0.84	Delete
CA1	✓	0.402	0.647	0.801	0.788	Delete
CA2	✓	0.582	0.748	0.722	0.722	Delete
CA3	✓	0.682	0.629	1	0.586	Delete
CA4	✓	0.678	0.829	0.633	1	Delete
CA5	✓	0.4	0.666	0.636	0.626	Delete
ROA1	✓	0.51	0.612	0.674	0.714	Delete
ROA2	✓	0.509	0.538	0.722	0.766	Delete
ROA3	✓	0.528	0.612	0.728	0.741	Delete
ROA4	✓	0.5	0.583	0.654	0.706	Delete
ROA5	✓	0.502	0.6	0.588	0.633	Delete
		Delete	Delete	Delete	Delete	

Figure 5: Normalized data of organizations RAI 1to ROA 5



Name	Active	INPUT	OUTPUT1	OUTPUT2	OUTPUT 3	
Unit		Input	Output	Output	Output	
POR1	✓	0.525	0.603	0.8	0.918	Delete
POR2	✓	0.506	0.548	0.786	0.789	Delete
POR3	✓	0.52	0.566	0.746	0.822	Delete
POR4	✓	0.4	0.592	0.804	0.836	Delete
POR5	✓	1	1	0.422	466	Delete
		Delete	Delete	Delete	Delete	

Figure 6: Normalized data of organizations POR 1to 5

RESULTS

The objective of the study is to evaluate and assess safety performance of DMUs in different Indian construction segments.

DEA with constant return to scale model- basic model

A construction segment is considered efficient when its objective function becomes unity. The input oriented maximization CCR – DEA model is used to obtain efficiency score. The results obtained from the models are summarized in Table 2. The efficiency scores indicate that five organizations have emerged as benchmarking units for the other 45 decision making units. The efficient units are POW5, CA1, CA5, POR4 and POR5 as the efficiency is equal to one and the other organizations are inefficient as efficiency is below one. It is also observed that POW5, CA1, CA5, POR4 and POR5 have become peer group for 20, 16, 18, 21 and 35 times respectively.

Table 2: Results of constant return to scale model – Basic model

Organization (DMU)	Efficiency	Rank	Peer group	Peer count
RE 1	0.51	23	POW5,CA1	0
RE 2	0.57	20	CA5,POR5	0
RE 3	0.60	19	CA1,POR4,POR5	0
RE 4	0.46	24	POR4,POR5	0
RE 5	0.65	15	POW5,CA5,POR5	0
CO 1	0.75	7	POW5,CA1,POR5	0
CO 2	0.67	14	POR4	0
CO 3	0.54	22	POR4,POR5	0
CO 4	0.71	11	CA1,POR4,POR5	0
CO 5	0.62	18	CA1, POR4, POR5	0
SEZ 1	0.63	17	POR4	0
SEZ 2	0.57	20	POR4, POR5	0
SEZ 3	0.79	4	CA5, POR5	0
SEZ 4	0.56	21	POR4, POR5	0
SEZ 5	0.76	6	CA5, POW5, POR5	0
POW 1	0.69	12	CA5	0
POW 2	0.63	17	POW5, CA1, POR5	0
POW 3	0.63	17	CA5, POR5	0
POW 4	0.71	11	POW5, CA5, POR5	0
POW 5	1	1	POW5	20
IRR 1	0.90	3	CA5	0
IRR 2	0.69	12	POW5, CA1, POR5	0
IRR 3	0.94	2	POW5, CA5	0
IRR 4	0.64	16	POW5, CA1, POR5	0
IRR5	0.64	16	POW5, CA5, POR5	0
UI 1	0.68	13	POW5, CA5, POR5	0
UI 2	0.65	15	POR4	0
UI 3	0.63	17	POR4	0
UI 4	0.65	15	POR4, POR5	0
UI 5	0.53	23	CA1, POR4, POR5	0
RAI 1	0.73	10	POW5, CA5, POR5	0
RAI 2	0.71	11	POW5, CA1, POR5	0

RAI 3	0.76	6	POW5, CA5, POR5	0
RAI 4	0.72	10	POR4	0
RAI 5	0.74	8	POR4, POR5	0
CA 1	1	1	CA1	16
CA 2	0.77	5	POW5, CA5, POR5	0
CA 3	0.73	9	POR4	0
CA 4	0.73	9	CA5, POR5	0
CA 5	1	1	CA5	18
ROA 1	0.73	9	POW5, CA5, POR5	0
ROA 2	0.71	11	CA1, POR4, POR5	0
ROA 3	0.71	11	CA1, POW5, POR5	0
ROA 4	0.71	11	CA1, POW5, POR5	0
ROA 5	0.72	10	CA1, POW5, POR5	0
POR 1	0.76	6	CA1, POR4, POR5	0
POR 2	0.77	5	POR4	0
POR 3	0.72	10	CA1, POR4, POR5	0
POR 4	1	1	POR4	21
POR 5	1	1	POR5	35

The inefficient units have to approach peer groups to become efficient. The organization in port segment (POR 5) is to be referred by inefficient units 35 times to become efficient and it is the best among the five efficient units. The organization is under real estate segment, RE4 is ranked last with an efficiency of 0.46. All the efficient units are from infrastructure segment only and none of the organizations from real estate segment are efficient. The results of mean scores of two segments in constant return to scale model are shown in Table 3. From mean efficiency scores, it is observed that the safety performance in real estate segment is only 0.63 that requires efforts from all the stakeholders to become efficient. Civil aviation and port segments are observed relatively better performing units among other infrastructure segments and still wide scope for improving efficiency to become peer units.

Table 3: Mean scores of constant return to scale model – Basic model

Real estate divisions (Scores)		Infrastructure divisions (Scores)	
Residential	0.56	Utilities /Power	0.73
Commercial	0.66	Utilities /Irrigation	0.76
SEZs	0.66	Urban Infrastructure	0.63
		Transportation/ Railways	0.73
		Transportation/ Civil Aviation	0.85
		Transportation/ Roadways	0.72
		Transportation/ Ports	0.85
Mean Score	0.63		0.75

DEA with constant return to scale model – special case

In the basic model of measuring efficiency three outputs were considered that is total number of accidents, man days lost and cost of accident damages. The total number of accidents is inclusive of first aid cases. Usually the number of first aid cases will be high in some decision making units. The first aid cases are nothing but giving immediate relief to an employee and return to the work place to resume normal duties immediately after treatment. The first aid cases are very minor and the possibility of man-days lost doesn't arise. The first aid cases were recorded by the safety department/ first aider to have an idea about nature of injuries and to implement remedial measures. The higher number of first aid cases

in an organization will have its influence on efficiency. To test the model behaviour, an attempt has been made to measure efficiency by excluding the first aid cases from the total number of accidents. The results of CRS model by excluding first aid cases are shown in Table 4.

The results indicate that POW 5, CA1, ROA 4, POR 4 and POR 5 have become efficient and ROA 4 has emerged as new efficient unit. The decision making units POW5, CA1, POR 4 and POR5 are efficient in both the cases. The number of first aid cases is influencing the efficiency of DMUs ROA 4 in the basic model and not become efficient. The efficiency of POR 3 approaching to unity (0.99) and little effort will make it efficient. The efficient unit of basic model CA 5 has become inefficient mainly due to presence of loss time and fatal accidents. The DMUs POW5, ROA4 and POR5 have become benchmarking units with peer count of 40, 43 and 37. None of the DMUs in real estate segment has become efficient and it indicates much effort are required to improve safety performance, even though efficiency scores are considerable better compared to basic model.

Table 4: Results of constant return to scale model – Special case

Organization (DMU)	Efficiency	Rank	Peer group	Peer count
RE 1	0.72	18	POW5, ROA4	0
RE 2	0.73	17	ROA4, POR5	0
RE 3	0.73	17	POW5, ROA4, POR5	0
RE 4	0.73	17	ROA4	0
RE 5	0.74	16	POW5, ROA4, POR5	0
CO 1	0.76	14	POW5, ROA4	0
CO 2	0.73	17	POW5, ROA4, POR5	0
CO 3	0.70	19	ROA4, POR5	0
CO 4	0.89	7	POW5, ROA4, POR5	0
CO 5	0.72	18	POW5, ROA4, POR5	0
SEZ 1	0.92	5	POW5, ROA4, POR5	0
SEZ 2	0.75	15	POW5, ROA4, POR5	0
SEZ 3	0.83	10	POW5, ROA4, POR5	0
SEZ 4	0.84	9	POW5, ROA4, POR5	0
SEZ 5	0.80	12	POW5, ROA4, POR5	0
POW 1	0.69	20	ROA4, POR5	0
POW 2	0.73	17	POW5, ROA4, POR5	0
POW 3	0.72	18	POW5, ROA4, POR5	0
POW 4	0.75	15	POW5, ROA4	0
POW 5	1	1	POW5	40
IRR 1	0.83	10	POW5, ROA4, POR5	0
IRR 2	0.75	15	POW5, ROA4, POR5	0
IRR 3	0.96	4	POW5, ROA4	0
IRR 4	0.75	15	POW5, ROA4, POR5	0
IRR5	0.76	14	POW5, ROA4, POR5	0
UI 1	0.73	17	POW5, ROA4, POR5	0
UI 2	0.72	18	POW5, ROA4	0
UI 3	0.70	19	POW5, ROA4	0
UI 4	0.81	11	POW5, ROA4, POR5	0
UI 5	0.70	19	POW5, ROA4, POR5	0
RAI 1	0.75	15	POW5, ROA4, POR5	0
RAI 2	0.74	16	POW5, ROA4, POR5	0
RAI 3	0.79	13	POW5, ROA4, POR5	0
RAI 4	0.86	8	POW5, ROA4, POR5	0

RAI 5	0.99	2	POW5, ROA4, POR5	0
CA 1	1	1	CA1	4
CA 2	0.80	12	POW5, ROA4, POR5	0
CA 3	0.74	16	POW5, CA1	0
CA 4	0.72	18	ROA4, POR5	0
CA 5	0.91	6	POW5, ROA4, POR5	0
ROA 1	0.74	16	POW5, ROA4, POR5	0
ROA 2	0.86	8	POW5, ROA4, POR5	0
ROA 3	0.91	6	POW5, ROA4, POR5	0
ROA 4	1	1	ROA4	43
ROA 5	0.98	3	ROA4	0
POR 1	0.79	13	POW5, CA1, POR5	0
POR 2	0.83	10	POW5, CA1, POR5	0
POR 3	0.99	2	POW5, ROA4, POR5	0
POR 4	1	1	POR4	1
POR 5	1	1	POR5	37

The mean values of efficiency segment wise were presented in Table 5. The mean scores of DMUs of real estate and infrastructure segments have been improved from 0.63 to 0.77 and 0.75 to 0.83. The mean scores show significant improvement in both the segments and the overall mean of efficiency was increased from 0.70 to 0.80, which is substantial.

Table 5: Mean scores of constant return to scale model – Special case

Real estate divisions (Scores)		Infrastructure divisions (Scores)	
Residential	0.73	Utilities /Power	0.78
Commercial	0.76	Utilities /Irrigation	0.81
SEZs	0.83	Urban Infrastructure	0.73
		Transportation/ Railways	0.83
		Transportation/ Civil Aviation	0.83
		Transportation/ Roadways	0.90
		Transportation/ Ports	0.92
Mean Score	0.77		0.83

The summary of results of constant return to scale under basic model and special case are represented in Table. 6. It is observed from summary of results that DMUs POW 5, CA 1, POR 4 and POR 5 have become efficient units in all the cases. The impact of first aid cases are clear in both the cases, as inefficient DMUs in basic model became efficient in the special case and vice versa due to presence of man days lost and fatal accidents. The previous studies on safety performance was compared technical efficiency among industries like steel, refractory's and construction (Beriha, Patnaik & Mahapatra, 2011) but the present study focussed to measure performance within Indian construction industry.

Table 6: Summary of results

CRS model			
Basic model		Special case	
Efficient units	Peer count	Efficient units	Peer count
POW5	20	POW5	40
CA1	16	CA1	4
CA5	18	ROA4	43
POR4	21	POR4	1
POR5	35	POR5	37

CONCLUSIONS

The main purpose of the study is to identify inefficient units in real estate and infrastructure segments of Indian construction industry with an objective to adopt best practices followed by benchmarking units so as to become efficient. DEA methodology quantifies how much efficiency score needs to be improved to reach at benchmarking unit's score. The total expenditure on safety related activities is considered as input and the outputs are the total number of accidents, man days lost due to an accident and total cost of accident damages. In the previous studies, the outputs are mainly different types of accidents but this study considered cost of accident damages also. The main reason for considering cost of damages is some accidents may not cause injuries but cause damage to the property. Two cases are considered in CRS model; basic model in which all the accidents are considered irrespective of its impact and special case in which first aid accidents are excluded as these accidents do not cause man days lost or cost to the DMU. The presence of first aid cases in total number of accidents has significant impact on efficiency scores and overall safety performance of real estate and infrastructure segments.

In both the cases, the mean efficiency scores of DMUs in real estate are lower than that of infrastructure and not even a single DMU was efficient from real estate segment. All the stakeholders are responsible for improvement of technical efficiency by strictly implementing safety systems and procedures. The DMUs POW5, CA1, POR4 and POR5 are efficient in all cases under both the models and inefficient DMUs approach the four benchmarking units; and implement safety systems practiced by the units. The DMU POR5 is considered to be best among the other three basing on peer count, followed by POW5, POR4 and CA1. The inefficient units may implement and practice the safety procedures followed by the benchmarking units to become efficient.

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