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## AIMS AND SCOPE

The JOURNAL OF CONSTRUCTION (JOC) is the official journal of the ASSOCIATION OF SCHOOLS OF CONSTRUCTION OF SOUTHERN AFRICA (ASOCSA). At this stage it is a bi-annual refereed journal serving all practitioners, professionals and clients in the construction sector including but not exclusive to civil engineers, electrical and electronic engineers, mechanical engineers, structural engineers, safety engineers, information and communication engineers, architects, building surveyors, construction managers, project managers, quantity surveyors, facilities managers, contractors, property developers, researchers, research managers, policy makers, instructors, educators, trainers and postgraduate students. JOC publishes quality papers aimed at advancing knowledge of the practice and science of construction while providing a forum for the interchange of information and ideas on current issues to be brought together. One of the primary objectives of the JOC is to promote the interface between current and topical construction research and practical application by disseminating in-depth research papers, reviews of projects and case studies, information on current research projects, comments on previous contributions, discussion on research,

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Topics in JOC include construction-related design strategies; usability and adaptability; material, component and systems performance; process control; alternative and new technologies; organisational, management and resource issues; human factors; environmental, quality and safety and health issues; cost and life cycle issues; sustainability criteria, indicators, measurement and practices; risk management; entrepreneurship; law, regulation and governance; design, implementing, managing and practicing innovation; visualisation, simulation, information and communication technologies; and education practices, innovation, strategies and policy issues.

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The pages should be numbered consecutively. There should be no loose addenda or notes or other explanatory material. The manuscript should be arranged under headings and sub-headings.

**Title page (page 1):** The first page of the manuscript must contain a concise and informative title, a secondary running title of not more than 75 characters and spaces, the name(s), the affiliation(s) and address(es) of the author(s) and the name, address, telephone, fax and email of the author who will be responsible for correspondence and corrections. The title should be in 12pt bold capitals, the name(s) of the author(s) in 10pt bold upper and lower case and the affiliation(s) and address(es) in 10pt upper and lower case with a single line space between each.

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#### Purpose of this paper

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What was found in the course of the work? This will refer to analysis, discussion, or results.

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All headings and sub-headings should be in 10pt bold capitals and the keywords themselves should be in 10pt bold upper and lower case.

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The introduction should clearly state the purpose (aims and objectives) of the paper. It should include key references to appropriate work, but is NOT the place for a comprehensive historical or literature review.

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The discussion should emphasise the implications and practical significance of research findings, their limitations, and relevance to previous studies.

#### Acknowledgements:

A short acknowledgement section of one paragraph is permissible at the end of the text.

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Conclusions should state concisely the most important propositions of the paper, as well as the recommendations of the authors based on the propositions.

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Figures will normally be reduced in size on reproduction and authors should draw with this in mind. With a reduction of 2:1 in mind, the authors should use lines not less than 0.25mm thick and upper and lower case lettering, the capitals of which should be 4mm high. Typewritten annotations are not acceptable.

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## INSTRUCTIONS TO AUTHORS

and any reference should be one line space immediately above the table and linked to the left margin. The table identification should be in bold. Identify all statistical methods and sources of data. Tables should only have horizontal lines, the heading and bottom lines being in bold. All words should be in upper and lower case lettering. The headings should be aligned to the left of their column, start with an initial capital and be in bold. Units should be included in the heading. Any explanations should be given at the foot of the table, not within the table itself.

**Table 1:** Components of expenditure.

Component	Expenditure (%)
Cleaning works	40,9
Mechanical services	37,7
Building works	13,6
Civil works	7,8
Total	100,0

(Northwood, 1995)

### Symbols, abbreviations and conventions:

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Bon, R. (1997) "The future of international construction." *Building Research and Information* 25, 137-41.

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Royal Institution of Chartered Surveyors (1980) *Report on Urban Planning Methods*, London.

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## EDITORIAL

The final issue of the present volume of the Journal of Construction (JOC) brings to a close another momentous year for the Association of Schools of Construction of Southern Africa (ASOCSA). Following a very successful 2nd Built Environment Conference in Port Elizabeth, in collaboration with the Council for the Built Environment (CBE) the first Council was elected. Further, ASOCSA committed itself to continue to grow the relationship between industry stakeholders and academia in the region. Several regional forums will be hosted with industry in the next few months. It was also unanimously decided to host the next conference in Cape Town in July 2008 with the 4th definitely destined for a Southern African location. Already the interest from international delegates in the Cape Town event is larger than for the previous two conferences. It is hoped that JOC will continue to be a vehicle to draw industry and academia closer together in a mutually beneficial partnership and that the papers published in this issue will be of interest to both academics and industry practitioners, even though they have more of an international flavour.

The papers address the participation of disadvantaged construction related organisations in Design, Operate and Transfer (DOT) programmes in South Africa compared with practices in the U.S.A. (Chileshe, Shakantu and Quashie), perceptions of Private-Public Partnership (PPP) stakeholders on the performance of operational PPP projects (Nyagwachi and Smallwood), construction professionals and project management competencies in Nigeria (Ogunsemi, Oyediran and Ekundayo), and the impact of training on HIV and AIDS awareness using an Indian pilot study (Haupt and Smallwood). The technical paper in this issue is by Bob Wilmot of the Hot Dip Galvanizers Association Southern Africa and deals with the key aspects of corrosion protection.

Special thanks to each of the contributing authors and reviewers for their contributions to the papers in this second issue of the Journal of Construction.

**Theo C Haupt**  
Cape Town, South Africa  
January 2008

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# CONSTRUCTION PROFESSIONALS AND PROJECT MANAGEMENT COMPETENCIES IN NIGERIA

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## ABSTRACT

Project in construction covers several areas of specialisation; hence the need for a competent, independent person or firm well trained and certified to carry out this comparatively new expanding role of project management based on knowledge and skills in the relevant discipline. This study was carried out to seek the opinions of the respondents and to determine the gap in project management competencies by determining the competencies of the various construction industry professionals involved in project management services. Data were collected from eighty construction stakeholders drawn from architecture, quantity surveying, estate surveying, building, civil engineering, clients and contractor organisations and were analysed using mean item score (MIS) and the Kruskal Wallis H test. The result showed that all the respondents believed that the quantity surveyor was the most competent, with 79% training in basic, core and optional competencies. The builder and estate surveyor came second with 78% each. The architect came fourth with 76% while the civil engineer came fifth with 70% training in project management competencies. The paper concludes that to be a competent project manager in the Nigerian Construction Industry, the listed construction industry professionals should undertake training in diverse areas lacking in their academic background and seek a balance of all the appropriate knowledge and skills as listed in the handbook of Masters in Project Management of the University of Lagos and the Project Management Book of Knowledge (PMBOK).

### Keywords:

Project managers, knowledge, skills, competencies, construction professionals, Nigeria.

## INTRODUCTION

The roots of twentieth century project management are generally accepted as lying in engineering and construction industries at the turn of the century, when early forms of project management were developed to improve planning and cost control. Within such a changing industry climate, project managers increasingly find themselves accountable not only for the technical content of the project as expressed by engineering and construction knowledge. Project managers find themselves confronted by issues and undertaking additional roles that have traditionally not been part of their responsibility. Bresnahan (2000) recognised this changing role for construction project managers and argued that they must supplement their traditional functions with other non – engineering knowledge and skills to meet today's professional demands for which they become responsible.

However, viewed from another perspective, it is believed that there is a need for the project management function itself to adapt to these changing industry conditions in order to maintain its relevance for project delivery well into the future (Lampel, 2001). The development of the requisite knowledge and skills needed to perform this expanding role has traditionally relied on engineering and technology degree programmes that are pursued in Nigerian institutions. Conflict does arise in the construction industry between the client's objectives and those of the individual firms or persons involved in the execution of a construction project, caused as a result of a variance from the set standard and specifications in terms of quality, cost, requirements and time expected by the client.

Thus, there is the need for the appointment of a competent project manager to resolve the conflicts in question to advance the project. Consequently, there is much controversy over who ought to assume this duty of project management among the listed construction related professionals – architects, quantity surveyors, estate surveyors, builders and civil engineers – based on their knowledge and skills in the relevant fields of project management practice. This is due to the fact project in construction covers several areas of specialisation, hence the need for a competent independent person or firm well trained and certified to carry out this comparatively new expanding role of project management to achieve the project's predetermined objectives within the constraints of available human and material resources (Oberlender, 1993). This research determined the gap in project management competencies by examining the competencies of the various construction industry professionals involved in project management services.

## LITERATURE REVIEW

The construction industry is a viable sector in the economy of any country. Therefore, management of this sector must clearly be defined and handed over to construction professionals that are well trained and certified in the field. By delegating the duty of management of construction project to the professional that possesses the relevant skills and knowledge in project management competence, the success of a construction project is guaranteed. In light of this, Birkhead (2000) asserts that project management is internationally recognised as a management tool that is critical for success in the current work environment and that competence can be measured in terms of training and certification.

### Project Management Competencies

Nkado (2000) defines competency as 'an ability that a person who works in a given occupational area should have subject to internal and external factors such as organisation type, size, age and activity levels' P. 481. Also, competency can be seen as the demonstration of an integration of knowledge, skills, personal attributes and values orientation (Westcott, 2003). In lieu of this, it is agreed that project management competence is attained through the combination of knowledge acquired during training and skills developed via experiences gained in its application (Edum – Fotwe & McCaffer, 2000). Lampel (2001) however categorises these competencies into technical, management, entrepreneurial, evaluation and rational competencies.

In a nutshell, Nkado (2001) authoritatively sets out the requirements for the assessment of competence as basic, core and optional competencies. Thus, competence is becoming increasingly prevalent as a defining dimension of training and certification.

### Current Training Needs of a Competent Project Manager

Bresnahan (2000) identifies the current training needs of a competent project manager as the basis for the requisite knowledge and skills needed in project management. The training needs are classified into three broad areas, which are:

- Technical training: time, cost, quality, risk, procurement and project integration management.
- Business/financial training: accounting principles and prac-

tices, financial management, business process analysts and financial management control.

- Human resource training: leadership, stakeholder management, communication, team building and negotiation skills.

### **Knowledge Input for Developing Competent Project Managers**

Project management competency is attained through knowledge acquired during training and the application of the acquired knowledge (Edum-Fotwe *et al.*, 2000). The generic areas of knowledge of a competent project manager as outlined by Birkhead (2000) are thereby listed as project integration, time, cost, procurement, quality and risk management.

### **Essential Project Management Skills**

The essential skills that often become relevant to construction project managers are leadership, communication, negotiating, influencing, team building, problem solving and decisiveness skills. These skills as developed by various construction industry professionals are a function of the knowledge input gained in their diverse disciplines.

### **Construction Industry Professionals**

The construction of a project of any kind involves the services of many people, directly and indirectly, who design, construct and maintain it from inception to completion, and to terminal demolition (Fadamiro and Ogunsemi, 1996). Adetola (2004) therefore lists the professionals actively involved in the construction industry to include, but not limited to the following, architects, quantity surveyors, structural, civil, mechanical and electrical engineers, town planners, estate surveyors, land surveyors, and builders. To achieve the purpose of this study, five of these professionals were selected; they included the architect, quantity surveyor, estate surveyor, builder and civil engineer.

### **Requirements of the Assessing Organization for Certification**

The Association of Project Managers and the Federal Government of Nigeria regulate the requirements for the practice of project management in Nigeria. The all encompassing requirement of these assessing organisations, which is the project manager's basic qualification, is training in one of the listed construction related professions, culminating in either a degree or diploma or both in a recognised institution of learning. It is in this regard that the Federal Government of Nigeria approved five professional bodies to render project management services. The architect, quantity surveyor, estate surveyor, builder and civil engineer.

### **Project Management in Crisis**

Aside from the misunderstanding that persists among construction professionals as to the most competent to handle project management services, there is a growing crisis in the field of project management. Most construction professionals now define themselves as project managers, irrespective of their knowledge and skills in the relevant field of project management. From a different perspective, the message is clear: It seems that the increase in certified project managers – offered by many professional institutes and coupled with the Federal Government Certification of Construction related professions – has not resulted in a corresponding decrease in failed or troubled projects. In fact, the opposite appears to be true.

Moreover, there seem to be more projects in chaos today than in previous times, despite the increase in certified project managers. How can this be? Well, professional thought on this trend, including the researchers' observations in this field, will be reviewed. These authors have written arguing the suitability of each of the professions for project management based on competence, knowledge and skills in the relevant fields and these are presented.

### **Project Management Competencies of the Nigerian Quantity Surveyor**

Odusami and Iyagba (2001) assert that the training and formal education of Quantity Surveyors in Nigeria encompass the necessary requirements needed for project management. The areas of training of Nigerian quantity surveyors include time, cost quality, human resource, communication and risk and project control management (Oladipupo, 2004, Mercy, 1997). This is in line with what Zack Jr. (2004) opined i.e. a solid foundation in the area of project control (cost engineering, estimation, scheduling, budgeting, cost tracking and trending) is a prerequisite to becoming a competent project manager in the construction industry.

### **Project Management Competencies of the Nigerian Architect**

Many people have argued that architects are most suitable for project leadership, based on their knowledge and skills in the relevant fields of project management. Fadamiro and Ogunsemi (1996) agreed to this on the premise that they are master builders who conceive the design or plan of the project and influence the type of structure. Also, they are better trained in dealing and communicating with clients as traditionally they are usually the first point of call – as perceived by Odusami, *et al.* (2001).

### **Project Management Competencies of the Nigerian Estate Surveyor.**

According to Oladipupo (2004), estate surveyors make the most competent project managers due to their knowledge and skills in the following areas: They are more adept, by nature of their training, at managing men, materials and other resources required or available in a project, i.e. they are skilled in resource management and administration. Odusami, *et al.* (2001) concluded that they are also trained in financial management, time and cost management including conducting feasibility and viability studies owing to the fact that their services are required prior to site acquisition and even after completion, until terminal demolition.

### **Project Management Competencies of the Nigerian Civil Engineer**

Odusami, *et al.* (2001) assert that construction professionals with a civil engineering background could be the most competent project managers – this on the premise that they are best trained in engineering design and detailing and also well versed in interpreting working drawings. Based on this knowledge they are able to see to the structural design and erection of the project, which can affect cost and avoid collapse. They are most competent because they have more technical and professional information on construction project, which helps them to check material and workman conformance to specification.

### **Project Management Competencies of the Nigerian Builder**

Having regard for the builder's educational background and training, professionals affirm that builders have more knowledge and skills in project management services. They are most trained and have a balanced and total knowledge of construction technology, management and economics due to their central position in the construction industry. By virtue of their training, they are experienced at managing men, materials and plant to achieve their responsibilities of project durability, quality attainment and buildability (Oladipupo, 2004; Odusami, *et al.*, 2001).

## **RESEARCH METHODOLOGY**

An appropriate methodology necessary for the achievement of the aim of this study was fashioned out. A survey was used to prepare a mental plan and scheme of attack for solving the problem in a systematic manner. This involved assessing professional opinions. Since the study deals with project management

competencies of Nigerian construction industry professionals, the target populations were construction professionals who were certified by the assessing organisations to practice project management services and they included architects, quantity surveyors, estate surveyors, builders and civil engineers. Also, the study universe included contributors to delivery of construction project, that is, the clients and contractors who usually work with project managers on construction project. The study focused on construction works generally and the study area was limited to Lagos State on the premise of location concentration of construction works, contractors and consulting firms' offices.

The sample size for the study was fixed at 125 and stratified random sampling (probability) was used to select members to elicit relevant data and reflect the heterogeneity of some populations. Two sets of questionnaires were self administered to the target respondents and this lasted for a month, that is, June 2006. Questionnaire 1 was sent out as a self-assessment of training to construction professionals while questionnaire 2 was sent out to clients and contractors to assess the project management competencies of the professionals. Data about academic programmes was obtained from the handbook of Masters in Project Management of the University of Lagos, Akoka. Out of a total of 75 questionnaires administered to construction professionals, 53 of them were returned while 50, which represented about 67% of the total sent out, were suitable for analysis. Out of a total of 50 questionnaires administered to both clients and contractors, 32 of them were returned while 30, which represented about 60% of the total sent out, were suitable for analysis.

The resulting respondents' responses were analysed analytically with descriptive and inferential statistics. Mean item score was used to analyse the likert scale data and this was calculated by:

$$MIS = \frac{\sum n_i k_i}{\sum N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1 + 0n_0}{N_5 + N_4 + N_3 + N_2 + N_1 + N_0}$$

Where:

- MIS = Mean item score
- $\sum N$  = Total number of respondents
- $N_5$  = The number of respondents that chooses 5, etc
- 0-5 = The various marks for the ranking of the factors as applicable in each case

Kruskal Wallis H statistics were used to test the significant difference in the level of project management competence of the listed construction professionals and the chi square test was later used to interpret the results generated from it, using the formula:

$$H = \frac{12}{n(n+1)} \sum_{i=1}^p \frac{T_i^2}{n_i} - 3(n+1)$$

Where:

- H = Kruskal Wallis Value
- n = Total number of sample
- T = Rank sum
- P = Number of sample

The test was undertaken at 95% confidence level, that is, level of significance = 5%.

## RESULTS

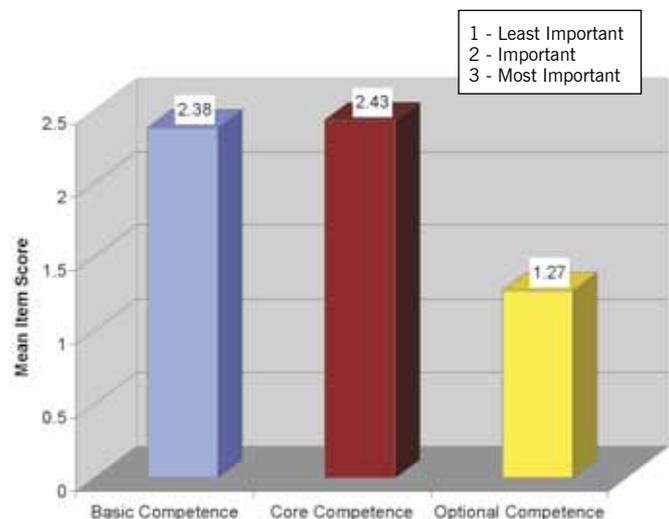
The data collected were scrutinised and presented in tables. The respondents who participated in the questionnaire survey 1: self-assessment of training were listed construction professionals and care was taken to ensure equal representation of the professionals. Table 1 shows the characteristics of the respondents used for the study. Of the respondents, we have 20% of each of architects, quantity surveyors, estate surveyors, builders and civil engineers. These numbers were deliberately selected to provide a uniform

basis for subsequently analysis. As depicted from the table, the mean years of experience was 11. The table also indicates that from questionnaire 2, administered to determine the gap in project management competencies of construction professionals, 36.7% and 13.3% use a public and private client respectively, while indigenous contractors scored 26.7%, with 23.3% remaining for non-indigenous contractors. Thus, with the information provided in Table 1, the data provided by the respondents was reached upon for the purpose of the analysis.

**Table 1:** Respondents' professions, years of experience, and type of clients/contractors.

Characteristics	Frequency	Percent
<b>Respondents' professions</b>		
Architects	10	20.00
Quantity Surveyors	10	20.00
Estate Surveyors	10	20.00
Civil Engineers	10	20.00
Builders	10	20.00
<b>Total</b>	<b>50</b>	<b>100.00</b>
<b>Years of experience of respondents</b>		
1 – 5	12	24.00
6 – 10	16	32.00
11 – 15	6	12.00
16 – 20	11	22.00
21 – 25	5	10.00
<b>Total</b>	<b>50</b>	<b>100.00</b>
<b>Mean years of experience = 11.10</b>		
<b>Type of client/contractors</b>		
Public Client	11	36.70
Private Client	4	13.30
Indigenous Contractor	8	26.70
Non-indigenous Contractor	7	23.30
<b>Total</b>	<b>30</b>	<b>100.00</b>

Figure 1 shows that core competence, with a mean item score of 2.43, was rated first in the requirements necessary for the assessment of project management competence. Basic competence came second with a mean item score of 2.38, while optimal competence ranked least with a mean item score of 1.27. This implies that project management competencies can be measured in descending order of core, basic and optional competencies.



**Figure 1:** Requirement for assessment of professional competence ranking.

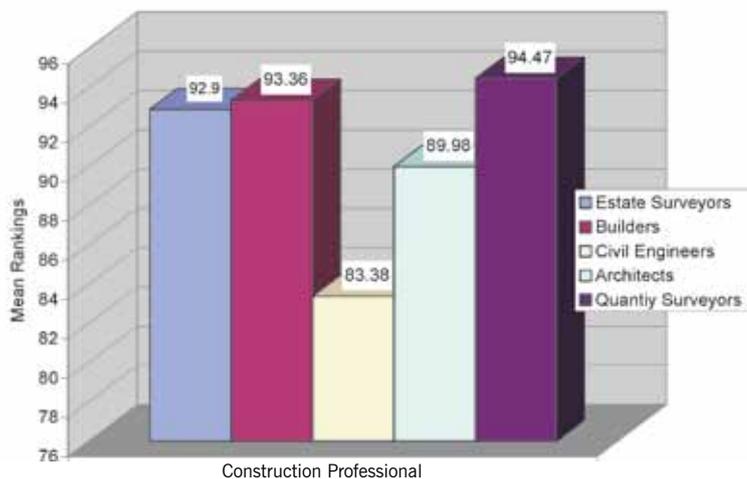
## Competencies of the listed professionals as project managers

As shown in Table 2, quantity surveyors, including estate surveyors, are rated as very good in basic competence while architects, builders and civil engineers are good. Quantity surveyors and builders are rated as very good in core competence while architects, estate surveyors, and civil engineers are rated good. Estate surveyors are rated as very good in optional competence while builders, quantity surveyors, architects and civil engineers are good. Figure 2 shows that quantity surveyors were rated top in project management competencies, with a total mean item score of 94.47, followed by builders and estate surveyors with 93.36 and 92.90 respectively. Architects were rated fourth, with a total mean item score of 89.98, while civil engineers were rated least competent with a score of 83.38.

**Table 2:** Self-assessment of project management competencies.

Competencies	Index of self-assessment competence				
	Estate Surveyors	Builders	Civil engineers	Architects	Quantity Surveyors
<b>Basic competence</b>					
Personal and interpersonal skills	5.50	5.70	5.70	5.90	6.30
Business skills	5.50	5.50	5.10	5.30	5.50
Information technology	5.80	5.70	4.50	5.30	5.80
Professional practice	6.00	5.67	5.30	6.10	6.30
Law	4.78	4.30	3.88	4.80	4.90
<b>Mean item score rank</b>	<b>5.52</b>	<b>5.37</b>	<b>4.90</b>	<b>5.48</b>	<b>5.76</b>
<b>Core competence</b>					
Construction contract practice	5.00	5.80	5.30	5.90	6.20
Construction technology	5.00	5.80	5.50	6.00	5.80
Construction economics/cost control	4.90	5.60	5.30	5.20	5.80
Procurement methods	5.11	5.20	4.90	5.50	5.60
Financial management	5.80	5.40	4.90	5.20	5.70
Contract administration / Project control	5.11	6.30	5.20	5.80	6.20
Marketing and accounting principles	5.30	5.30	4.20	4.33	5.22
<b>Mean item score rank</b>	<b>5.17</b>	<b>5.62</b>	<b>5.04</b>	<b>5.42</b>	<b>5.78</b>
<b>Optional competence</b>					
Dispute resolution procedures	5.00	5.90	4.70	4.75	4.89
Development appraisal	6.10	4.89	4.90	5.20	5.50
Facilities management	5.50	5.80	5.00	5.30	5.20
Property investment funding	6.00	5.30	4.30	4.70	4.78
Valuation	6.50	5.20	4.70	4.70	4.78
<b>Mean item score rank</b>	<b>5.82</b>	<b>5.42</b>	<b>4.72</b>	<b>4.93</b>	<b>5.03</b>
<b>Total</b>	<b>92.90</b>	<b>93.36</b>	<b>83.38</b>	<b>89.98</b>	<b>94.47</b>

1 – extremely poor; 2 – very poor; 3 – poor; 3 – poor; 4 – moderately good; 5 – good; 6 – very good; 7 – extremely good.



**Figure 2:** Basic, core and optional competencies combined.

### Assessment of Professional's Competence by Clients and Contractors

It was hypothesised that there was no significant difference in the level of project management competencies of the listed construction professionals, and alternatively that there was significant difference in the level of project management competencies of the professionals. The respondents who participated in the questionnaire survey 2 were clients and contractors involved in project management. They further assessed the project management competencies capacity of the listed Nigerian Construction industry professionals and the gap in the project management competencies.

**Table 3:** Level of overall service competence of project managers by clients/contractors.

Project managers	Mean item score (MIS)	Kruskal Wallis mean	Rank
Architects	3.56	11.06	3
Quantity surveyors	4.86	24.07	1
Builders	3.50	10.50	4
Civil engineers	3.88	14.25	2
Estate surveyors	3.33	10.37	5

1 – extremely poor; 2 – poor; 3 – moderately good; 4 – good; 5 – extremely good.

$\chi^2_{4, \alpha=0.05} = 12.694$  ( $P < 0.05$ ), Asymp. Sig. = 0.013

Table 3 revealed that quantity surveyors were rated as 'extremely good', civil engineers, architects and builders were rated as 'good' while estate surveyors were rated as moderately good, according to the clients' and contractors' perspectives of their overall project management competence. The Kruskal Wallis mean also confirmed the ranking indicated by the table. Again the Kruskal Wallis H test on the results in Table 3 shows that there is a significant difference (gap) in the level of project management competencies of the listed construction professionals. Consequently, the alternative hypothesis that there is significant difference (gap) in the level of project management competencies of the various construction industry professionals is thereby upheld.

### DISCUSSION OF FINDINGS

The analysis carried out on the competencies of construction professionals revealed that these could be adequately measured in descending order of core, basic and optional competencies. Earlier, the Royal Institution of Chartered Surveyors (1998) cited in Nkado (2001) authoritatively set out the requirements necessary for the assessment of professional competence by listing the competencies required of a competent project manager in descending order of core, basic and optional competencies.

However, the results have shown from the analysis of self-assessment in core competence that the quantity surveyors ranked first while builders, architects, estate surveyors and civil engineers followed respectively. This, however, is not surprising since the courses under core competencies are similar to those in the quantity surveying syllabus and in line with Zack Jr's (2004) assertion that well trained quantity surveyors are vast in financial, time, cost, integration and human resources management. In basic competence, the results show that quantity surveyors are the most competent, followed by estate surveyors, architects, builders and civil engineers respectively. This, however, is also unsurprising when considered in line with their academic syllabi.

The analysis further revealed that estate surveyors ranked as most competent in optional competence followed respectively by builders, quantity surveyors, architects and civil engineers. These results confirmed Odusami and Iyagba's (2001) assertions that an estate surveyor is more adept, by nature of his training, at managing facilities and carrying out feasibility and viability studies, development appraisal and property investment funding, all

of which are optional competence areas of project management competence.

The research revealed that core competence is a major area of specialisation of a competent project manager, while optional competence is a minor area of specialisation (Nkado, 2001). Moreover, the results show that quantity surveyors are most competent in basic, core and optional competencies combined followed by builders, estate surveyors, architects and civil engineers respectively.

Further to what the self-assessment affirmed, i.e. that quantity surveyors are the most competent, analysis of the clients' and contractors' perspective also confirmed that quantity surveyors were most effective and that they satisfied them effectively as expected. Clients and contractors also believed that civil engineers, architects and builders were effective, while estate surveyors were moderately effective as shown in the results.

The test statistics showed that professionals require diverse training, that is, different knowledge and skills, to be competent project managers in the Nigerian construction industry. Again this is unsurprising as they are trained using different academic syllabi and, in line with their responses, there are areas in which they need to undertake training to compensate for those areas lacking in their academic background, which is entirely different.

### CONCLUSIONS AND RECOMMENDATIONS

Based on the data presentation and analysis, the following conclusions are drawn from the findings of the study.

- (1) Construction professionals concluded that core competence is the more appropriate requirement necessary for the assessment of project management competencies.
- (2) According to the professionals, estate surveyors are rated as very good in financial management only, while in the knowledge input area of core competency, they are rated as good. Builders are rated as very good in contract administration, construction economics, construction technology and construction contract practice while they are rated as good in the remaining two aspects. Civil engineers are only rated as very good in construction technology while they are rated as good in the remaining core competency areas. Architects are rated as very good in construction contract practice, construction technology and contract administration while in the rest of the areas, they are rated as good. The professionals agreed that quantity surveyors are very good in all the core competency areas such as construction contract practice, construction technology, cost control, procurement methods, financial management and project control. In marketing and accounting principles they are rated as good.
- (3) Thus quantity surveyors are the most competent, based on training in core competency areas, due to the fact that most of the courses undertaken in project management at master's level are offered in their first-degree academic programme. Builders, architects and estate surveyors followed respectively while civil engineers ranked last.
- (4) According to level of satisfaction of the clients and contractors as regards the overall service project management competence of the listed construction professionals, quantity surveyors ranked highest while civil engineers and architects ranked second and third respectively with builders and estate surveyors being the fourth and the last.
- (5) The results showed that there is significant difference in the level of project management competence required by the various construction professionals in the Nigerian construction industry and that they require different training needs to compensate for those areas lacking in their academic background as project managers.

Based on the conclusion, the following recommendations were proposed for policy decisions.

- (1) Civil Engineers, estate surveyors and architects need more knowledge input and training in the core competency area of project management, while civil engineers, builders and architects also need further training in basic competence. Hence,



the academic syllabi of these listed professionals should be revised to ensure greater competence in these areas.

- (2) To be a competent project manager in the Nigerian construction industry, the listed professionals should undertake training in diverse areas and seek a good balance of all the appropriate knowledge and skills required of a competent project manager as listed in the handbook of masters in project management of the University of Lagos and the Project Management Book of Knowledge (PMBOK).

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# THE IMPACT OF TRAINING ON HIV AND AIDS AWARENESS: A PILOT STUDY

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## ABSTRACT

Training is an intervention frequently referred to in construction health and safety literature as an effective means of improving health and safety behaviour and performance. Given that HIV and AIDS present a threat of pandemic proportions to the construction industry, training has also been presented as an imperative strategy to improve knowledge, awareness and sexual behaviour. However, as far as the authors are aware, there have been no studies to determine the effectiveness of such training in achieving these goals. This paper reports the findings of a pilot study conducted in India that sought to measure the change in knowledge and awareness levels of delegates attending a workshop relative to HIV and AIDS.

### Keywords:

HIV, AIDS, training, knowledge, awareness

## INTRODUCTION

Several studies have confirmed the benefits that accrue from health and safety (H&S) training (Jannadi and Al-Sudairi, 1995; Mottram, 2005; Teo, Ling and Ong, 2005; Lingard and Rowlinson, 2005). H&S education and training are necessary to develop core and surface H&S competencies (Smallwood, 2006). However, it is necessary to establish an environment within which H&S information can be communicated effectively (Lingard and Rowlinson, 2005). Training plays a pivotal role in ensuring that construction workers are competent to fulfil their H&S responsibilities. A strong H&S training programme has been identified as being a feature of organisations possessing a good H&S performance track record (Smith et al., 1978).

Effective communication, given that it provides information that has relevance and meaning to those receiving it (Emmitt and Gorse, 2003), is essential to achieve desired objectives. Preferably, this communication should be two-way. While it has been established that important information may be better communicated face-to-face through information sessions, presentations, meetings and training and workshop sessions (Lingard and Rowlinson, 2005) these are typically one-way communications with presenters sharing volumes of information without evaluating the impact of the sessions on the knowledge base of the participants. Evaluation should be designed to determine whether the training sessions achieved their objectives and whether they created a common interpretation and shared understanding of the information disseminated. According to Emmitt and Gorse (2003) common experiences, education and training enable the recognition and communication of information that has congruence. Further, when the outcome of the communication process does not achieve the desired objectives it is viewed as a failure. The challenge is to develop methods to measure the extent of the achievement of these objectives.

There is a close relationship between education and labour conditions and the labour market (Lundall, 2003). The South African government has captured the essence of this pivotal relationship in the Occupational Health and Safety Act (OHSA) 85 of 1993. In terms of OHSA clause 8(1), all employers in South Africa are required to provide and maintain a working environment that is safe and without risk to the health of their employees. Additionally, OHSA clause 8(2)(e) requires employers to provide such information, instructions, training and supervision as may be necessary to ensure the health and safety at work of their workers. Several studies have confirmed a well-established link

between safety training and the performance of companies. For this reason high performing companies invest larger percentages of their payroll cost in training compared to the recommended industry norm.

Several authors have argued that there is a positive correlation between H&S training and overall improved H&S performance (Mottram, 2005; Smallwood, 2006; Hinze 1997, Rowlinson, 2005). Further, training presents the opportunity to communicate information not only to increase knowledge and awareness but also to change behaviour. Given that HIV and AIDS present a threat of pandemic proportions to the construction industry, training has also been presented as an imperative strategy to improve knowledge, awareness and sexual behaviour.

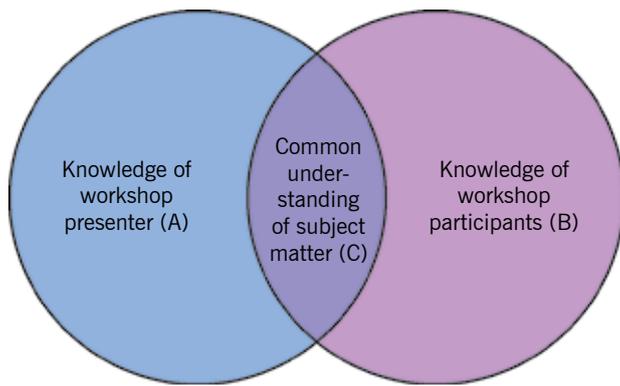
It is necessary for training outcomes to be evaluated against training objectives (Lingard and Rowlinson, 2005). According to Cooper and Cotton, (2000), this evaluation is important for the following reasons, namely:

- An indication of whether objectives have been met and whether any additional training is required.
- Provision of feedback to training providers about their own performances.
- A cost-benefit analysis of training investment.
- Benchmarking against other H&S interventions.

However, as far as the authors are aware, there have been no studies to determine the effectiveness of such training in achieving these goals. This paper reports the findings of a pilot study conducted in India that sought to measure the change in knowledge and awareness levels of delegates attending a workshop relative to HIV and AIDS. The authors are aware that it is important to consider the long-term effects of training and not just the short-term impact, especially considering the gravity of the HIV and AIDS threat, not only to construction but to society as a whole. From Figure 1 it is evident that for training to be effective and result in positively changed behaviour and improved knowledge, the workshop presenter (A) and workshop participants (B) need to achieve (C) an optimal common and shared knowledge and understanding of the subject matter being presented. The ideal would be for  $\sum A + B = C$ .

## RESEARCH METHODOLOGY

The sample comprised 81 delegates in India who attended an HIV and AIDS workshop designed to heighten awareness of the threat posed by the pandemic in that country and the construction sector in particular. Prior to commencement of the workshop, participants in the survey were asked to respond to 20 statements about HIV and AIDS. Upon completion of the workshop, participants were asked to respond to the same 20 statements about HIV and AIDS. The responses (B) were analysed using the Statistical Package for Social Sciences (SPSS). The measures of central tendency, namely the mean scores of the responses to each of the statements were compared and the differences calculated (C) relative to the preferred response (A). These differences were ranked to determine the extent of the shift and/or change in the knowledge of the participants where this had occurred. These findings were indicative of the extent of the merging of the knowledge of the workshop presenter (A) and the knowledge of the participants (B). The frequency distribution of the responses to each of the 20 statements is shown in Tables 1 and 2.



**Figure 1:** Creation of shared understanding (Adapted from Emmitt and Gorse, 2003).

## FINDINGS

### Pre-workshop Responses

This phase of the evaluation sought to establish the baseline knowledge level of participants about various aspects of HIV and AIDS that have been found to be typically problematic and confusing. The difference between the desired response and that actually given was calculated. The intent of the evaluation, given the objectives of the workshop, was to determine how far the response differences were from 0. The larger the difference, the greater the level of knowledge deficiency about the particular issue. The maximum possible difference was 5.

The zero-rated responses to each of the 20 statements presented are as follows:

- Having sex with a virgin cannot cure a person with HIV and AIDS. Rather having unprotected sex with anyone especially if their serostatus is not known is risky.
- Everyone, whether homosexual or heterosexual, can contract HIV and AIDS.
- Having a sexually transmitted infection increases the risk of being affected with HIV. It is therefore important to have sexually transmitted infections treated.
- It is almost impossible to be infected with HIV by being bitten by a mosquito. Mosquitoes can only transmit HIV if 10 million mosquitoes feed on an HIV affected person and then all of them feed on another person.
- It is not possible at this stage to determine one's HIV status using a home test. It is expected that such a test kit will be developed much like a home pregnancy test kit.
- Presently no vaccine against HIV and AIDS exists that can cure a person. There are many trials underway in various parts of the world with potential vaccines. None are commercially available yet.
- For HIV to be transmitted by deep or open mouth kissing will require the transfer of large volumes of blood. This is typically not the case.
- While a healthy diet and regular exercise cannot cure HIV, they improve the quality of life of a HIV positive person and delay the onset of AIDS.
- Given that much research has been done to improve condoms with respect to their strength and film thickness, condoms only marginally reduce the pleasure of having sex.
- HIV and AIDS are not the same. HIV is a virus while AIDS is the condition of an HIV positive person whose T4 cell count has dropped to below about 200.
- At this point in time no doctor can cure anyone from HIV or AIDS.
- Since HIV positive persons can lead normal lives for many years after infection without showing any symptoms, it is not possible to see when someone is HIV positive.
- A person who knowingly infects another with HIV can be sued. There have been many cases around the world where persons have been prosecuted for this kind of conduct.

- It is possible for a person to live a normal life while being HIV positive as suggested in point 8.
- Given that HIV is only a retrovirus it is not possible to die of HIV. Rather a person dies from AIDS.
- Among several other theories it is theorised that HIV originated in monkeys in Africa. However, there has been no conclusive evidence to support this assertion.
- HIV is not a disease. It is a retrovirus.
- Given the stigma attached to being aware that someone is HIV positive and the traditional reluctance of construction employers to become involved in dealing with the threat of HIV and AIDS, it is seen to be more a community problem and not a work one.
- It is not possible for a HIV positive person to infect an already infected person.
- Several studies have confirmed the existence of several strains and types of HIV, making its treatment and the development of a vaccine increasingly difficult.

The results in Table 1 are ranked by the actual differences in initial knowledge compared with these zero-rated responses.

It is evident that, prior to the workshop, respondents were most unsure about whether there was only a single strain of HIV (3.51); whether a HIV positive person could infect another HIV positive person (2.26); whether HIV and AIDS was perceived to be a problem at work (2.01); and whether HIV was a disease (2.00). The aspects that presented least difficulties were whether having sex with a virgin could cure someone of HIV and AIDS (0.33); whether only homosexuals could contract HIV and AIDS (0.34); whether having a sexually transmitted infection reduced the likelihood of being infected with HIV (0.47); and whether someone could be infected by being bitten by a mosquito (0.49).

### Post-workshop Responses

On the other hand, based on the results in Table 2 it is evident that after the workshop the knowledge base of respondents relative to all 20 aspects of HIV and AIDS had been impacted to varying degrees. The aspects that respondents were now most unsure about were whether an HIV positive person could infect another HIV positive person (1.97); whether condoms reduced the pleasure of having sex (1.90); whether one could die from HIV (1.87); and whether HIV and AIDS were problems at work (1.80). The aspects that presented least difficulties were whether having a sexually transmitted infection reduced the likelihood of being infected with HIV (0.32); whether there was only one strain or type of HIV (0.31); whether only homosexuals could contract HIV and AIDS (0.26); and whether someone could be infected by being bitten by a mosquito (0.26).

The findings after comparing the before and after as shown in the Difference A column of Table 3 indicate that the knowledge base of the workshop delegates demonstrated the most shift relative to whether a person could live a normal life while being HIV positive (1.11); whether HIV was a disease (1.03); whether a person who knowingly infects another person could be sued (0.68); and whether one could see whether someone was HIV positive (0.67). On the other hand their knowledge base shifted the least relative to whether a person could die of HIV (0.04); whether condoms reduced the pleasure of having sex (0.06); whether only homosexuals could contract HIV and AIDS (0.08); and whether having sex with a virgin could cure a person of HIV and AIDS (0.10).

With respect to the aspects of HIV and AIDS that respondents required further shifts in their knowledge base to achieve zero-rating or common shared understanding with the workshop presenter (Area C in Figure 1) the rankings in descending order are shown in the Difference B column of Table 3 as follows:

- An HIV positive person can infect another HIV positive person – 1.97.
- HIV and AIDS is not a problem at work – 1.80.
- HIV originated in monkeys in Africa – 1.48.
- Condoms reduce the pleasure of having sex – 1.10.
- One can die of HIV – 1.13.
- HIV can be transmitted by deep or open mouth kissing – 1.13.

- HIV is a disease – 0.97.
- A healthy diet and regular exercise can cure HIV – 0.83.
- A person who knowingly infects another with HIV can be sued – 0.71.
- One can see when someone is HIV positive – 0.60.
- A doctor can cure you – 0.57.
- HIV and AIDS are the same – 0.55.
- A person can live a normal life while being HIV positive – 0.50.
- Home testing is possible to determine HIV status – 0.49.
- A vaccine exists that can cure you – 0.43.
- Having sex with a virgin can cure a person of HIV and AIDS – 0.43.
- Having a sexually transmitted infection reduces the risk of being infected with HIV – 0.32.
- There is only one strain or type of HIV – 0.31.
- Only homosexuals can contract HIV and AIDS – 0.26.
- A person can be infected with HIV by being bitten by a mosquito – 0.26.

**Table 1:** Pre-workshop responses.

Statement	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Having sex with a virgin can cure a person of HIV and AIDS	5.0	71.3	16.3	3.8	1.3	2.5
Only homosexuals can contract HIV and AIDS	12.7	48.1	34.2	3.8	-	1.3
Having a sexually transmitted infection reduces the risk of being infected with HIV	18.4	38.2	28.9	9.2	2.6	2.6
A person can be infected with HIV by being bitten by a mosquito	9.9	56.8	18.5	7.4	3.7	3.7
Home testing is possible to determine HIV status	19.0	25.3	32.9	13.9	7.6	1.3
A vaccine exists that can cure you	13.8	30.0	26.3	17.5	10.0	2.5
HIV can be transmitted by deep or open mouth kissing	9.9	40.7	23.5	4.9	19.8	1.2
A healthy diet and regular exercise can cure HIV	11.5	24.4	38.5	9.0	10.3	6.4
Condoms reduce the pleasure of having sex	19.0	19.0	29.1	12.7	12.7	7.6
HIV and AIDS are the same	7.9	31.6	32.9	6.6	14.5	6.6
A doctor can cure you	11.4	24.1	30.4	15.2	13.9	5.1
One can see when someone is HIV positive	6.4	35.9	23.1	5.1	17.9	11.5
A person who knowingly infects another with HIV can be sued	10.3	3.8	5.1	11.5	24.4	44.9
A person can live a normal life while being HIV positive	7.5	3.8	15.0	10.0	43.8	20.0
One can die of HIV	6.4	14.1	26.9	6.4	26.9	19.2
HIV originated in monkeys in Africa	27.2	1.2	2.5	8.6	40.7	19.8
HIV is a disease	11.5	15.4	16.7	2.6	25.6	28.2
HIV and AIDS is not a problem at work	6.3	15.0	18.8	7.5	36.3	36.3
A HIV positive person can infect another HIV positive person	16.3	12.5	20.0	5.0	25.0	21.3
There is only one strain or type of HIV	46.1	7.9	10.5	25.0	7.9	2.6

**Table 2:** Post-workshop responses.

Statement	Unsure	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
A person can be infected with HIV by being bitten by a mosquito	3.2	71.0	22.6	3.2	-	-
Only homosexuals can contract HIV and AIDS	3.2	71.0	22.6	3.2	-	-
There is only one strain or type of HIV	17.2	48.3	24.1	6.9	3.4	-
Having a sexually transmitted infection reduces the risk of being infected with HIV	3.2	64.5	29.0	3.2	-	-
A vaccine exists that can cure you	-	66.7	30.0	-	-	3.3
Having sex with a virgin can cure a person of HIV and AIDS	-	73.3	20.0	-	3.3	3.3
Home testing is possible to determine HIV status	9.7	54.8	25.8	3.2	-	6.5
A person can live a normal life while being HIV positive	-	-	-	6.7	36.7	56.7
HIV and AIDS are the same	-	61.3	32.3	-	3.2	3.2
A doctor can cure you	3.3	53.3	36.7	-	3.3	3.3
One can see when someone is HIV positive	-	70.0	16.7	-	10.0	3.3
A person who knowingly infects another with HIV can be sued	6.5	-	-	3.2	22.6	67.7
A healthy diet and regular exercise can cure HIV	-	50.0	36.7	3.3	-	10.0
HIV is a disease	-	61.3	16.1	-	9.7	12.9
HIV can be transmitted by deep or open mouth kissing	-	51.6	16.1	6.5	19.4	6.5
HIV originated in monkeys in Africa	16.1	3.2	-	12.9	29.0	38.7
HIV and AIDS is not a problem at work	-	23.3	20.0	-	26.7	30.0
One can die of HIV	3.3	33.3	13.3	-	23.3	26.7
Condoms reduce the pleasure of having sex	12.9	32.3	19.4	16.1	6.5	12.9
A HIV positive person can infect another HIV positive person	9.7	25.8	6.5	3.2	19.4	35.5



**Table 3:** Comparison of means of responses.

Mean	Std. Dev.	Difference from expected response
1.33	0.88	0.33 (1)
1.34	0.85	0.34 (2)
1.47	1.14	0.47 (3)
1.49	1.13	0.49 (4)
1.70	1.22	0.70 (5)
1.88	1.29	0.88 (6)
1.88	1.33	0.88 (6)
2.01	1.34	1.01 (8)
2.04	1.51	1.04 (9)
2.08	1.37	1.08 (10)
2.11	1.37	1.11 (11)
2.27	1.54	1.27 (12)
3.71	1.64	1.29 (13)
3.39	1.45	1.61 (14)
2.91	1.57	1.91 (15)
2.94	1.94	1.94 (16)
3.00	0.80	2.00 (17)
3.01	1.55	2.01 (18)
2.74	1.80	2.26 (19)
1.49	1.58	3.51 (20)

Mean	Std. Dev.	Difference from expected response
1.26	0.58	0.26 (1)
1.26	0.58	0.26 (1)
1.31	0.97	0.31 (3)
1.32	0.60	0.32 (4)
1.43	0.82	0.43 (5)
1.43	0.94	0.43 (5)
1.49	1.15	0.49 (7)
4.50	0.63	0.50 (8)
1.55	0.93	0.55 (9)
1.57	0.97	0.57 (10)
1.60	1.13	0.60 (11)
4.39	1.28	0.61 (12)
1.83	1.21	0.83 (13)
1.97	0.49	0.97 (14)
2.13	1.41	1.13 (15)
3.52	1.81	1.48 (16)
3.20	1.63	1.80 (17)
2.87	1.78	1.87 (18)
2.10	1.58	1.90 (19)
3.03	1.92	1.97 (20)

Statement	Pre-workshop	Post-workshop	Difference A	Ranking	Difference B	Ranking
A person can live a normal life while being HIV positive	3.39	4.50	1.11	1	0.50	13
HIV is a disease	3.00	1.97	1.03	2	0.97	7
A person who knowingly infects another with HIV can be sued	3.71	4.39	0.68	3	0.71	9
One can see when someone is HIV positive	2.27	1.60	0.67	4	0.60	10
HIV originated in monkeys in Africa	2.94	3.52	0.58	5	1.48	3
A doctor can cure you	2.11	1.57	0.54	6	0.57	11
HIV and AIDS are the same	2.08	1.55	0.53	7	0.55	12
A vaccine exists that can cure you	1.88	1.43	0.45	8	0.43	15
A HIV positive person can infect another HIV positive person	2.74	3.03	0.29	9	1.97	1
HIV can be transmitted by deep or open mouth kissing	1.88	2.13	-0.25	10	1.13	4
A person can be infected with HIV by being bitten by a mosquito	1.49	1.26	0.23	11	0.26	19
Home testing is possible to determine HIV status	1.70	1.49	0.21	12	0.49	14
HIV and AIDS is not a problem at work	3.01	3.20	0.19	13	1.80	2
A healthy diet and regular exercise can cure HIV	2.01	1.83	0.18	14	0.83	8
There is only one strain or type of HIV	1.49	1.31	0.18	14	0.31	18
Having a sexually transmitted infection reduces the risk of being infected with HIV	1.47	1.32	0.15	16	0.32	17
Having sex with a virgin can cure a person of HIV and AIDS	1.33	1.43	0.10	17	0.43	15
Only homosexuals can contract HIV and AIDS	1.34	1.26	0.08	18	0.26	19
Condoms reduce the pleasure of having sex	2.04	2.10	0.06	19	1.10	6
One can die of HIV	2.91	2.87	0.04	20	1.13	4

## CONCLUSION

It is evident from the study that workshops as a strategy to communicate information for the sole purpose of increasing knowledge and awareness are effective. The study found that measured against baseline knowledge about HIV and AIDS of workshop participants there were varying degrees of change in this knowledge base. This change was either in a positive and negative direction resulting in the gap between the initial knowledge level and the preferred knowledge level either decreasing or increasing. Where the gap has widened it is necessary to address the particular knowledge area with an appropriately designed and evaluated intervention. It was also noted that relative to all the aspects of HIV and AIDS the group had not achieved the preferred level of knowledge with respect to any aspect. The workshop presenter and workshop participants had therefore not achieved the optimum common and shared knowledge and understanding of the subject matter being presented. Consequently  $\sum A + B \neq C$ . To determine whether the positive changes in knowledge and awareness levels translate into changed sexual behaviour there is a need for additional evaluations of the same group of delegates over time. To eventually achieve changed behaviour and the ideal of  $\sum A + B = C$ , repeated training relative to HIV and AIDS is required.

The next phase of this project will be to broaden the scope of the workshops and training seminars beyond HIV and AIDS and also to work longitudinally with a sample of construction workers on a structured programme of information sharing and knowledge improvement.

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# FACTORS AFFECTING THE PARTICIPATION OF DISADVANTAGED CONSTRUCTION RELATED ORGANISATIONS (DCBOS): A COMPARATIVE STUDY OF THE USA AND SOUTH AFRICA

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## ABSTRACT

### **Purpose:**

This paper sought to identify the key problematic issues affecting DCBOs in the participation of the Design, Operate, Transfer (DOT) programmes within the South African and USA construction industries, and secondly to provide the solutions to the problems thus identified.

### **Design/Methodology/Approach :**

Using an exploratory approach of extensive literature review and drawing on the authors' experiences (USA and South Africa) through case studies.

### **Findings:**

Financial, technical and management, equipment and personnel factors identified as main barriers. Procurement related issues such as selection of DCBO, contract administration, contract size and location also found to impede the participation process.

### **Research Limitations:**

Draws on literature review from a small fraction of the USA and South African construction industries, and lack of empirical studies exist within this emergent field. Future research should adopt a quantitative approach to enable some descriptive statistics for cross comparison purposes.

### **Practical Implications:**

Contributes towards the removal of barriers in the participations of DCBOs in DOT and thus assist the development of firms.

### **Originality/Value:**

Provides a theoretical framework for conditions necessary for the creation of a level competition playing field on which DCBOs can compete fairly for and participate in DOT programmes.

### **Keywords:**

Certification, Discrimination, Disadvantaged Business Enterprises, Procurement, Quality Management, South Africa, USA

## INTRODUCTION

Within the USA Construction Industry, the larger, well-established construction firms have to work with disadvantaged business enterprises (DBEs) that sometimes lack expertise and experience. When the DBEs lack expertise and experience, it affects the smooth management of the construction projects, if problems are not identified in the early stages of the construction management process. State governments have systems to help DCBOs working on state construction contracts. The certification application process for DBEs to work on Federal Highway Administration (FHWA) funded projects affects the number of the DBEs applying for certification. Disadvantaged Business Enterprises (DBEs) are businesses owned and managed by minorities. Minorities are Women, Native Americans, African Americans, Asian, Hispanic American and Disabled persons. The majority of the enterprise should be owned by any of the minorities involved in the management and running of the day-to-day affairs of the firms or organisations. The Federal Government DBE programme also includes

Alaskan Natives, Pacific Islanders, Aleuts, and any persons who are not minorities but who are socially disadvantaged according to its definition. Socially and economically disadvantaged owners must demonstrate long standing, chronic and substantial disadvantage since the business is not owned by the person cited as a minorities group.

Larger organisations within the construction industry have to work with the disadvantaged construction business related organisations (DCBO) through quality management and production issues and furthermore, the well established organisations within the construction industry have taken greater steps to monitor contractual arrangements. Although the respective governments (USA and South Africa) have taken steps to ensure that the DCBOs are encouraged to participate in construction contracting, i.e. through certification programmes, there has been little research undertaken to study the quality of management and production of DCBOs within the construction industry in order to highlight the issues of management and production. This is what has driven research into issues highlighting partnerships between DCBOs and leading construction organisations during the project management life cycle. The noted omission being the motivation for this research.

This paper outlines the research conceptual framework, methodology, and research instrument, before presenting the research findings. In concluding, it suggests and identifies the key issues affecting disadvantaged business enterprises (DBEs) or disadvantaged construction related organisations (DCBOs) in the participation of the Design, Operate and Transfer programmes within the USA and South African construction industries, acknowledges soft skills as being the most desirable project management skills necessary and highlights the management and production of quality related issues emergent in the partnership between large organisations and disadvantaged business enterprises during the whole life project cycle.

## RESEARCH METHODOLOGY

An exploratory approach is used in this on-going research. As asserted by Chileshe (2004), the exploratory stage is an extensive literature review of the management writing. For the purpose of this research, it is aimed at identifying key issues affecting disadvantaged business enterprise (DBE) participation in the Design, Operate and Transfer programmes within the South African and USA construction industries, and, secondly, identifying the desirable project management skills necessary. Another objective was to highlight the management and production of quality related issues emergent in the partnership between large organisations and disadvantaged business enterprises during the whole life project cycle. The research process can be identified as having three distinct phases, namely literature review, pilot study and phase three as the main study. The findings reported here are drawn mainly from an extensive literature review in phase one. In achieving the aims and objectives of this research, a robust methodology is being developed as part of an on-going process. This is encapsulated in Figure 1.1.



Figure 1: Figure process diagram for Phase 1.

## DEFINITION OF CONCEPTS

According to Forza (2002), before starting theory testing survey research, the researcher has to establish the conceptual model by providing construct names and nominal definitions; propositions; explanation and boundary conditions. Furthermore it can be argued that concepts form the essential meaning of a study. It's against this background that the following section presents the clear identification, labels and definitions of all the constructs considered relevant in this study. According to the U.S. Department of Transportation, the Federal Transit Administration and the Metropolitan Atlanta Rapid Transit Authority (MARTA) use the following definitions:

- Disadvantaged business enterprise.
- Owned and controlled.
- Mentor.
- Protégé.

Within the South African context, the following definition is used:

- Historically disadvantaged

### *Disadvantaged Business Enterprises or Historically Disadvantaged*

A disadvantaged business enterprise (DBE) is a small business concern that is at least 51% owned by one or more socially and economically disadvantaged individuals or, in the case of any publicly owned business, at least 51% of stock is owned by one or more socially and economically disadvantaged individuals; and (ii) whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it. Within the South African context, the phrase used is that of 'historically disadvantaged' implying individuals discriminated against under apartheid.

### *Owned and Controlled*

Owned and controlled means a business that is at least 51% owned by one or more socially and economically disadvantaged individuals or, in the case of a publicly owned business, at least 51% of the stock is owned by one or more socially and economically disadvantaged individuals, and whose management and daily business operations are controlled by one or more such individuals.

### *Mentor*

A mentor is a contractor acting in a position of trust, guiding, advising, and counselling a DBE firm needing such assistance to successfully pursue high construction work.

### *Protégé*

A protégé is defined as a firm receiving guidance and assistance needed to further its expertise and experience in accomplishing specific goals.

Given the definition of the major concepts, the following section highlights the role of the federal and states governments and highlights some of the key issues affecting the disadvantaged

business enterprise and secondly, seeks to identify the desirable project management skills necessary and highlight the management and production of quality related issues emergent in the partnership between the large organisations and disadvantaged business enterprises during the whole project life cycle.

## THE FEDERAL AND STATES GOVERNMENTS AND DCBOS

### *USA Perspective*

In 1999, the final rules for Disadvantaged Business Enterprises (DBEs) firms or companies involvement in United States Department of Transport (U.S.A DOT) projects funded by the federal government was issued. The rules changed the arrangement of relatively small sized business enterprises undertaking USA DOT projects. These final rules appear as 49 Code of Federal Regulations (CFR) Part 26. The major objectives of the programme are:

- To ensure non-discrimination in the award and administration of DOT-assisted contracts.
- To create a level playing field on which DBEs can compete fairly for, and participate in, DOT-assisted contracts and/or subcontracts.
- To ensure that only firms that fully meet 49 CFR Part 26 eligibility standards are permitted to participate as DBEs.
- To help remove barriers to participation of DBEs in DOT - assisted contract.
- To assist the development of firms that can completely successfully in the market place outside the DBE programme.
- To provide appropriate flexibility of recipients of Federal financial assistance in establishing and providing opportunities for DBEs. Programme Plan.

Furthermore, the State governments across federation have in place procedures to meet the Federal Highways Administration (FHWA) guidelines contained in Title 49 CFR, Part 26, to assist the DBEs in participating on FHWA funded projects. The above not only help the DBEs to work on the FHWA funded contracts, but also to develop skills and qualifications to work outside FHWA contracts.

### *South African Perspective*

Almost 10 million historically disadvantaged South Africans still live in slums that lack basic shelter, drinking water, sanitation, solid waste disposal, electricity, and safe and affordable transportation (USAID, 2006). For historically disadvantaged South African companies, the South African International Business Linkages (SAIBL) offers training and business capacity support. Some of the construction related services include proposal development for tenders' productivity improvements, quality assurance and accreditation; and identifying private and public

financing programmes (SAIBL, 2006).

For U.S. companies, South African corporations, and multinationals, the SAIBL identifies procurement sources and promotes business partnerships with South Africa's historically disadvantaged companies. According to SAIBL (2006), some of the services include:

- Identifying qualified suppliers of goods and services.
- Identifying private and public financing programmes.

According to Heritage (2006), South Africa permits foreign investments in most sectors and generally does not restrict the form or extent of foreign investment. The article further argues that the Black Economic Empowerment strategy establishes a scorecard with targets for equity ownership, management, procurement, and equality in employment for 'historically disadvantaged' individuals. This 'Investment Freedom' forms one of South Africa's ten economic freedoms (Heritage, 2006) and accounts for a scale of 50% where 100 equates to most free, therefore it can be concluded that the investment freedom overall achieves a medium or average scoring.

## KEY ISSUES AFFECTING THE DCBOS

The key issues can be classified into soft and hard factors. As asserted by several researchers, soft factors are people-oriented whereas 'hard' factors are 'technical'. Drawing from the experience of the quality management discipline, Flynn *et al* (1995) similarly categorised the role of quality management practices into core and infrastructure, which create an environment supportive of the use of core practices. This can be likened to building and civil engineering works where civil engineering provides the infrastructure such as roads and bridges as access to the core activities of hospitals, which are a product of the building works. The Delaware Department of Transportation identified the following areas as requiring assistance, namely; financial, technical and management, equipment, and personnel.

### Financial

Financial assistance relates to the working capital.

### Technical and Management

According to the Delaware Department of Transportation, Technical and management assistance cover a wide range of activities, including day-to-day guidance as well as long term guidance for business planning.

### Equipment

Business decisions may impact on the overall success of an organisation, and one of the key areas is the utilisation of plant. So often organisations are faced with the dilemma of whether to 'buy or hire' plant, more so on highway constructions where there is always a requirement for plant utilisation.

### Personnel

Human skills are vital for the success of a business. Construction is acknowledged to be labour intensive; as such, selection of key personnel for highway construction comes into play. In addition to the universally accepted requirement for the Construction and Production process, namely the 4Ms (Money, Materials, Manpower and Machinery) as discussed above, other procurement related issues need to be taken into account and these are discussed in the following subsections.

### Selection of DBE for Construction Contracts

The selection of DBE to work on federal government funded contracts is through certification, which is through the unified certification programme (UCP). Before the unified certification programme came into being, DBEs had to apply for certification with every agency that they wished to work for, which was a long, difficult process, time consuming and financial costly. With the UCP in place, a DBE can be certified in one agency and have its certification recognised by all agencies within the UCP (NCHRP, 2006).

### Contract Administration

Very few DBEs have the skills to undertake contracts as prime

contractors and here economic factors play part. According to the National Cooperative Highway Program SYNTHESIS 343, locations and contract size of the project also play part. Contract sizes and locations of the projects were noted as the primary factors influencing the number of DBEs bidding as prime contractors. It should also be noted for DBE programmes, that when as few as one or two DBEs lose their eligibility owing to growth (graduation) or personal net worth limitations, the impact on the availability of DBE firms bidding as prime contractors in that State can be significant. This is particularly noticeable in those States where a limited number of DBE firms have the capacity and qualifications to bid as prime contractors (NCHRP, 2006).

## DESIRABLE PROJECT MANAGEMENT SKILLS FOR DCBOS

Given the key issues identified in Section 5.0, one of the objectives of this research was to identify the desirable project management skills emergent in the partnership between large organisations and disadvantaged business enterprises during the entire project. Quashie and Chileshe (2006,) citing Wideman (2006), identified six phases of the Project Life Cycle namely concept, definition, design, development, application; and post application. Figure 2 is one such example of the stages in the project life cycle.

Other authors such as Stuckenbruck (1981) identify four phases namely feasibility, design, execution and implementation. In terms of the amount of work involved, the execution phase accounts for about 60% of the entire Project Life Cycle. It is therefore evident that the necessary skills required for this stage

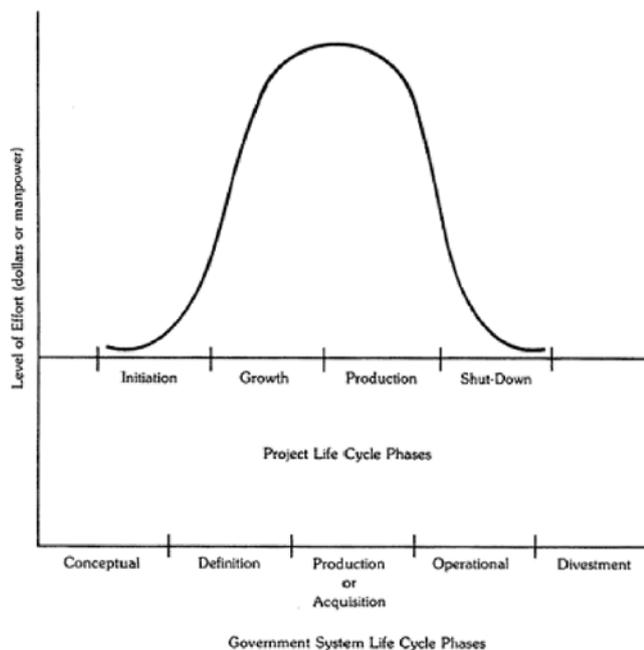


Figure 2: Government systems life phases. (Source: Widerman, 2006)

According to Rolf and Chileshe (2006), the project manager needs the skills and knowledge to handle the human problems that arise because normal patterns of human behaviour are characteristically accelerated and accentuated in project work. Furthermore, Young and Duff (1990) argue that project managers require such skills not only in demonstrating competence, but in promoting a professional image in construction.

### Classification of Project Management Skills for DBCOs

Chileshe and Haupt (2005) classified the skills and attributes of project managers into the following categories:

- Strategic factor
- Project control
- Technical
- Commercial
- Organisation and people

Given the key issues identified as impacting the DCBOs, there is a requirement for personnel involved with overseeing projects to have the necessary project management skills. For instance, under Section 5.3: Equipment, DBEs are faced with making decisions regarding plant. The strategic factor contains such attributes as 'Acceptance of Responsibility' and 'Decision Making'. Similarly the 'Financial Issues,' such as working capital, could be addressed by DCBOs through the acquisition of the 'Commercial' attributes such as 'Entrepreneurship'; 'Ability to Conduct Research'; 'Marketing Skills'; and most importantly, 'Financial Management'. The 'People' factor or 'Soft Issues' identified earlier in the paper would require such skills and attributes as 'Leadership Capability'; 'Negotiation Skills'; 'Supervisory Skills'; and Ability to Train Others'. These desirable project management skills would set the foundations in meeting the conditions necessary for the creation of the level playing field.

## CONDITIONS NECESSARY FOR THE CREATION OF A LEVEL PLAYING FIELD

The major thrust of this paper was to identify the conditions necessary for the creation of a level playing field on which DBEs can compete fairly for, and participate in, DOT. The following section highlights some of the financial conditions identified from the extensive review. Issues of finance have been selected as the prime example, as research has shown that financial matters contribute more to businesses going bankrupt.

### Financial

- Conditions and terms of payment for the DBEs should exclude demand notes.
- The above condition is achievable through the utilisation of a time note. This entails the mentor (see definition) providing working capital either in a lump sum or an open-ended direct payment basis to the protégé.
- The prime contractor could provide a performance and payment bond in the amount of 100% of the contract price.

### Technical and Management

The Delaware Department of Transportation Mentor/Protégé Program is quite clear as to the form of Technical and Management assistance that could be provided to the DBEs. It's not the intention of this paper to revisit all of the conditions but rather to summarise them for the benefit of the readers. In essence these pertain to assistance in the following areas:

- Project related matters.
- Interpretation of plans and specifications and subsequent bidding, estimating and pricing.
- Implementation of procedures for budgeting, projecting cash flow and bookkeeping.

### Equipment

The following are equipment related issues that need consideration in order to level the playing field. Leasing must be done to a valid written agreement, and the circumstances of the lease must be beneficial.

### Personnel

Competition is of paramount importance. Research shows that protégés are better placed to complete a particular subcontract through the engagement of specialised personnel. The conditions required under this issue related to:

- The lending of personnel being limited to workers with special expertise.
- Lending of personnel must have advance written approval from the department on each project.

Other conditions worth noting pertain to contract administration; selection process and the certification programmes.

## CROSS COMPARISONS OF FINDINGS BETWEEN USA AND SOUTH AFRICA

The literature review indicates that there are some commonalities in the factors affecting the participation of disadvantaged construc-

tion related organisations in both countries. The fact that both governments have measures in place to assist these organisations is indicative of the problem. For example, within South Africa and outside the construction sector, for many historically disadvantaged farmers and entrepreneurs, USAID's services are the only forms of assistance and mentoring they receive. According to USAID (2006), these include facilitating technical assistance and training to help small- and medium-sized firms identify new markets, build production and management capacity, secure financing to expand and, ultimately, create sustainable private sector employment.

## LIMITATIONS

Some limitations of the research need to be acknowledged. The paper would be incomplete without a statement on 'Limitations and Delimitations' of the study. Delimitations imply limitations on the research design that you have imposed deliberately. These delimitations usually restrict the populations to which the results of the study can be generalised. Limitations, on the other hand, refer to restrictions in the study over which you have no control. For example, you may be limited by the method to only a narrow segment of the total population you wish to study, or you may be limited by the method you elect to use, Rudestam and Newton (2000).

This research has both delimitations and limitation in the sense that it represents a small fraction of the USA Construction Industry and the issues discussed are only limited to the Disadvantaged Business Enterprises. Secondly, the methodological issues relate to the approach adopted, namely that of the qualitative approach. Therefore, while the results cannot be generalised at this stage, further research should be conducted using a triangulated approach to include a survey of DBEs to ascertain whether the issues identified from the literature review actually occur in the real world.

## CONCLUSIONS

This paper has investigated the factors affecting the participation of Disadvantaged Business Enterprises (DCBOs) within the South African and USA construction industries. Through a review of related literature, the key issues affecting the DCBOs in the participation of the Design, Operate and Transfer programmes within the USA construction industry and the desirable project management skills necessary for the execution of such duties have been identified.

### Review of Aim 1

To identify the key issues affecting the disadvantaged construction business organisations (DCBO) in the participation of the Design, Operate and Transfer (DOT) programmes within the South African and USA construction industries. From the review of related literature, findings indicate that the key issues pertain to financial, technical and management, equipment, and personnel. Equipment related issues are concerned with decision making. This involves deciding whether to buy or rent equipment. As observed from the literature, while these problems don't so much affect well-established contractors, decision making can be a major dilemma for DCBOs as this is an investment-making decision and appraisal system, which can have a huge impact on the overall profitability of an organisation. Idle plant can consume FOG (fuel, oil and gas) expenditure, whereas renting has to be in line with the programme going according to timetable.

### Review of Aim 2

To identify the desirable project management skills necessary and highlight the management and production of quality related issues emergent in the partnership between large organisations and disadvantaged business enterprises during the whole project life cycle. Human and technical skills were identified as necessary for the DCBOs to attain level playing fields. Given the issues identified under the technical and management; financial; equipment and personnel, it's evident that interplay of soft and hard skills is required among the DCBOs. Other factors impeding the participation of DCBOs were found to be procurement related, such as selection of DBE for construction contracts, contract ad-

ministration matters and other factors such as contract size and location. The certification process is another aspect that requires attention to level the playing fields.

In conclusion, the key findings of this exploratory research will ensure that the DBEs or DCBOs are not discriminated against in the award and administration of DOT assisted contracts; will strive to highlight the conditions necessary for the creation of a level playing field on which DBEs can compete fairly for, and participate in, DOT; and finally ensure that the DBE programme is narrowly tailored in accordance with applicable law. Furthermore, the literature review identified that there is a need for the provision of a gateway relative to the South African organisations to promising markets in the world. This is only achievable through empowering business through trade and investment partnerships between historically disadvantaged South African small and medium enterprises and U.S. companies, South African corporations, and multi-nations. The paper has major implications as it will contribute towards the removal of barriers to the participation of DCBOs in DOT and thus assist the development of firms that can compete successfully in the marketplace, outside the DBE programme.

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# SOUTH AFRICAN PUBLIC PRIVATE PARTNERSHIP (PPP) PROJECTS

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## ABSTRACT

The purpose of this paper is to report on case study reviews of South African Public Private Partnership (PPP) projects. The research investigated perceptions of PPP stakeholders on the performance of operational PPP projects.

A case study approach was adopted to examine various performance aspects of operational South African PPP projects. The research was a multi-case study design. Each individual case study consisted of a 'whole' study, in which facts were gathered from the selected PPP projects and conclusions drawn on those facts. A web-based questionnaire was used to capture the experiences and perceptions of various actors involved directly or indirectly in selected PPP projects.

Empirical evidence from the research indicates that South Africa has developed a robust policy and regulatory framework for PPPs, has an inadequate level of PPP awareness and training, and lacks project management capacity to facilitate deal flow.

The findings from the research make an invaluable and original contribution to the PPP body of knowledge; amplify the need for further research; refine our understanding on operational performance of PPP projects, and provide direction for policy and decision makers in the government and private sector within South Africa and beyond.

### Keywords:

Construction, Projects, Public Private Partnership

## INTRODUCTION

In the recent past, many countries have seen a tremendous increase in cooperation between the public and private sectors for the development and operation of infrastructure. Such PPP arrangements have been driven by limitations in public funds to cover desired investments and the need to leverage expertise from the private sector, in order to improve the quality and efficiency of public services (Grimsey and Lewis, 2004).

PPPs are relatively new in South Africa and to date have attracted limited investigation. This is notable as significant financial and other resources are involved and according to Khosa (2000), the perception exists that service delivery in most parts of the country is still poor.

This research project aims to further knowledge on the performance of operational South African PPP projects. The objectives of the study are to: examine performance of operational South African PPP projects; contribute towards the existing PPP body of knowledge, and provide direction for a sustainable PPP system nationally and beyond. The results of the study will lead to formal conclusions and recommendations to inform decision making.

## REVIEW OF RELATED LITERATURE

### PPP History

PPPs, though relatively new in South Africa, have a long history dating back to the time of concessions, which were used in the nineteenth century to finance infrastructure such as railways and highways in Europe, America, Asia, and Africa.

One of the best-known infrastructure projects in terms of waterworks is the Suez Canal, which according to Hamilton (1997), was a financial success until it was nationalised in the mid-1950s. Unfortunately, during the same period, many other large infrastructure projects failed elsewhere in the world, resulting in huge financial losses.

Toll roads were established in the United States, where between 1789 and 1900 there were more than 2 000 private corporations operating turnpikes in Pennsylvania, New York, Ohio, Michigan and elsewhere, because of the government's inability to provide adequate highways. Italy opened the world's first modern tolled motorway between Milan and the Lakes in 1924. The first modern motorways in France and Italy were constructed in the 1950s and 1960s.

Spain embarked on its motorway programme in the mid-1960s as the national budget was considered inadequate to meet the demands of a booming tourist industry. The solution adopted was to use the private sector financing. The new Spanish motorway companies were all private entities, although they were subjected to a high degree of state monitoring and control.

The energy crisis of the 1970s led to the collapse of most PPP companies in Italy, Spain, and France. In France, the state had to intervene, take over some of the companies and assimilate them into the public system of infrastructure. A similar development in Spain in 1983 led to the collapse of three companies representing about 15% of the motorway sector. Changed economic conditions saw the reverse process in the 1980s. Today, PPP projects in Italy and Spain are profitable, with some of them traded and quoted on the local stock exchanges.

### Important Statistics

Table 1 provides a snapshot of infrastructure projects in low and middle-income countries by region and type. Projects include management or lease contracts, concessions, greenfield projects, and divestitures. The database contains projects dating from 1984 to 2005. In Sub-Saharan Africa, there are a total of 69 PPP projects, of which 12 (17%) reached financial closure by the end of 2005.

**Table 1:** Types of PPP projects by region and type (1984-2005).

PPP Type	East Asia and Pacific	Europe and Central Asia	Latin America and the Caribbean	Middle East and North Africa	South Asia	Sub-Saharan Africa
Concession	28	13	8	6	0	16
Divestiture	75	192	171	1	15	6
Greenfield project	285	33	279	20	101	32
Management and Lease Contract	3	6	20	0	0	15
<b>Grand Total</b>	<b>391</b>	<b>244</b>	<b>478</b>	<b>27</b>	<b>116</b>	<b>69</b>

Data Source: World Bank and PPIAF, PPI Project database.

## RESEARCH

### Methodology

A case study approach was adopted to examine various performance aspects of operational South African PPP projects. The research was a multi-case study design. Each individual case study consisted of a 'whole' study, in which facts were gathered from the selected PPP projects and conclusions drawn on those facts. A web-based questionnaire was used to capture the experiences and perceptions of various actors involved directly or indirectly in selected PPP projects.

The sample stratum consisted of 19 PPP institutions throughout South Africa. The study was limited to operational South African PPP projects registered in accordance with Treasury Regulations<sup>1</sup> as at December 2005 and other projects that reached financial closure before the Public Finance Management Act of 1999 came into effect. 12 Responses were received, which equates to a response rate of 63%.

A multi-case study design was employed and a cross-case comparison is presented. Each case study was treated as a 'whole' study following replication logic. The operational PPPs were investigated for performance in different institutions in separate geographical locations. The cases investigated were selected from a list of projects available at the PPP Unit website database (National Treasury, PPP Unit, 2006).

Selection was based upon three criteria: stage in the implementation process; sector, and potential willingness to participate in the study. The study began after piloting the instrument in November 2006, and ended in February 2007.

### Types and Description of Projects

Selected operational PPP projects, representing various sectors, in different stages of operational phase, were investigated with regard to operational performance relative to aspects such as risk, affordability, responsibility, budget, project management, and legal and regulatory framework.

A cross-case comparison is presented in the following material. To protect confidentiality, names of the individuals are not used. However, names of organisations are provided to enhance the truthfulness of the findings. The PPP projects case studies are identified as Case A, B, C etc. respectively.

There were two categories of PPP projects - Type I and II. Type I operational PPP projects commenced after the promulgation of the Public Finance Management Act (PFMA) in 1999, and Type II PPP projects were operationalised before 1999, but some cases were considered since they were rich in operational experience. The two categories of PPP projects considered, with brief descriptions are represented in Table 2.

#### Case A: Inkosi Albert Luthuli Hospital, Department of Health, KwaZulu Natal

This South African pioneering PPP project was conceptualised in 2000 (PPP Quarterly, 2001) and reached financial closure on 6 December 2001. The process took five months of negotiation between various PPP actors. The Net Present Value of the project is R5 billion. The agreement provides for the supply and maintenance of specialised medical equipment and certain hospital upgrade and facilities management, over a period of 15 years.

#### Case B: Fleet Management, Department of Public Works, Northern Cape

This PPP fleet management project reached financial closure on 31 October 2001. The five-year contract worth R37 million per annum involved the Northern Cape Department of Transport, and Pemberley Investments (Pty) Ltd, comprised of Imperial (Pty) Ltd and Afrika Kosini. The service contract is for the provision of quality and well maintained vehicles for use by Northern Cape departments within approved budget allocations for the province. This PPP project provides a good lesson for the establishment of more fleet projects across the country.

#### Case C: Eco-tourism, Manyeleti three sites, Department of Environment and Tourism, Limpopo

Three 30-year Limpopo eco-tourism PPP projects were signed

in December 2001. The concession deals, located in the Manyeleti game reserve, require concessionaires to pay the province a concession fee for the rights to develop and operate tourism businesses under specified conditions in three areas: The Khoko Moya Camp, concessioned to Khoko Moya Wilderness Trails (Pty) Ltd; the Honeybadger Camp to Tinswala Lodges (Pty) Ltd; and Pungwe Camp, concessioned to Pungwe Game Reserve (Pty) Ltd. The three concessions involved upgrading existing facilities, re-design, construction, and operation of the facilities.

#### Case G: State Vaccine Institute, Department of Health

According to PPP Quarterly (2002), the South African Government has traditionally been involved in the manufacture of human vaccines through the State Vaccine Institute in Pinelands, Cape Town. The process of restructuring the State Vaccine Institute started in 2000, with a new entity, called Biovac Consortium, appointment for a five-year programme for the manufacture of a limited number of vaccines. Marketing of the vaccines in the SADC region will be a primary aim of the PPP project, which reached financial closure in April 2003.

#### Case H: Humansdorp District Hospital, Department of Health, Eastern Cape

The 80-bed PPP project reached financial closure in June 2003 and consists of a revitalised, refurbished and upgraded modern hospital with a long-term maintenance and non-clinical services agreement in operation. As a co-location hospital, various medical facilities are shared between the private and public sectors. The private operator is Metro-Star Hospital.

#### Case I: Head Office Accommodation, Department of Trade and Industry, Gauteng

The Head Office Accommodation PPP project is a 25-year design, finance, build, operate, and transfer project for the multi-purpose trade and industry campus, located on a 4 ha site on Nelson Mandela Drive. The project was initiated in January 2001 and reached financial closure in August, 2003.

#### Case J: Cradle of Humankind – Maropeng. Departments of Finance and Tourism

The Cradle of Humankind World Heritage PPP project in Gauteng reached financial closure in October 2003. It is a DBOT, ten-year project.

#### Case K: Social Payment Grant System, Department of Social Development/State.

The Free State signed the three-year PPP deal with AllPay (Pty) Ltd in April 2004 for the Social Grant Payment System. The short period for the deal was due to the anticipated creation of a national agency for managing social grants. The deal envisaged a 28% cost saving in the cost of delivery of social grant services (PPP Quarterly, 2004).

#### Case L: Ilembe Water Concession, Ilembe District Municipality, KwaZulu Natal

Located in South Africa's KwaZulu-Natal province, the then Borough of Dolphin Coast (BODC), now Ilembe District, signed a 30-year concession contract in 1999 with Siza Water Company. The contract provides for overseeing, managing and implementing the provision of water and sanitation services within the then Borough of Dolphin Municipal boundary. However, the geographical coverage area for the contract changed as a result of the restructuring and demarcation of municipal boundaries (Robbin, 2003).

Issues that arose out of these changes are not the subject of this research, but nevertheless would present greater insights into operational problems of PPPs should they be researched further. The BODC municipality chose the PPP approach for water and sanitation provision because the municipality lacked adequate funding and experience to upgrade and expand services to cater for the growing investment and management responsibility.

1. Treasury Regulation 16 of Public Finance Management Act, 1999

### Case M: The Pretoria to Maputo N4 Toll Road, Trans African Concessions

The N4 represents a unique transboundary PPP agreement signed between the governments of South Africa and Mozambique in 1996 for a 30-year period, during which Trans African Concessions (TRAC) designed and built, and is now operating the N4 toll road from Witbank, South Africa to Maputo, Mozambique. Control and management of the N4 toll way will revert back to the two governments at the expiry of the concession period.

### Case N: Correctional Facilities in South Africa

The Departments of Correctional Services (DCS) and Public Works used a model of privately built and operated prisons to establish the above PPP. The above model was based on the UK models. The South African government signed two 25-year concessions for maximum security prisons in Bloemfontein and Louis Trichardt as part of the Department of Public Works' Asset Procurement and Operating Partnership Systems (APOPs) in the year 2000 at a total cost of R1.7 billion. The consortium that developed the PPP is responsible for designing, building, financing, operating and transferring the prisons back to government at end of concession.

### Case O: N3 Toll Concession – Cedara in KwaZulu Natal to Heidelberg in Gauteng

This 30-year concession is part of the South African Government's efforts to develop infrastructure through alternative sources such as PPPs so as to relieve the burden of financing public infrastructure through tax-based revenues. According to SANRAL (2006) the N3 Toll road project represents a successful PPP project that can be replicated in other parts of the country. The value of the N3 Toll Road Project was R3.5 billion, covering a distance of 418 km from Cedara in KwaZulu-Natal to Heidelberg in Gauteng Province. The project received the 1999 Project Finance International Deal of the Year Award (SANRAL, 2006). The aims of this project

were: to reduce congestion; reduce transport costs; reduce cost of goods; enable faster, safer and more efficient transport; and reduce travelling time between Durban and Johannesburg.

### Case Q: Nelspruit Water Concession, Ehlanzeni District Municipality, Mpumalanga

The controversy-ridden Nelspruit Water concession faced a lot of challenges from the labour union movement. The contract was finally signed in April 1999, despite strong opposition from the South African Municipal Workers Union (SAMWU), and the Congress of South African Trade Unions (COSATU) to extend the coverage of services to the town's poorer areas.

### Case S: Fleet Management, Eastern Cape Department of Transport

The Fleet Management PPP project undertaken by the Eastern Cape Department of Transport (ECDT) is a pioneering and innovative restructuring of the former Mayibuye Transport Corporation (MTC), which according to the PPP Quarterly (2002) has been operating on a government subsidy. In November 2001, the ECDT appointed Deloitte & Touche Management Solutions as Transaction Advisors to conduct an options analysis, feasibility study, and drive the procurement process. The ECDT PPP project is among the twelve projects signed in terms of Treasury Regulation 16, as at January 2006.

### Case T: Bakwena Platinum Toll Road PPP project

The Bakwena Platinum Toll Road is a good example of the major role being played by PPPs in the development of South Africa's infrastructure. The 30-year concession is valued at R3.5 billion. The Highway comprises two of the main access roads to Pretoria: The N4-West, linking Pretoria to the Botswana Border (290 km), and the N1-North, connecting Pretoria to Warmbaths (90 km) and ultimately, to Zimbabwe.

**Table 2A:** Short profile of PPP projects – Type I.

PPP Project	Duration (Years)	PPP Model	Investment Level	Financing Structure (%) **	Risk Allocation
<b>Type I</b>					
Albert Luthuli Hospital	15	DFBOT	R5b	E & D	P / Party
Fleet Management/Cape	5	DFO	R181m	Ey	P / Party
Eco-tourism, three sites Manyeleti	30	DFBOT	R29m	E	P / Party
Universitas and Pelonomi Hospitals	N/A	N/A	N/A	N/A	N/A
Information Systems Project	N/A	N/A	N/A	N/A	N/A
Chapman's Peak Drive Toll Road	N/A	N/A	N/A	N/A	N/A
State Vaccine Institute	4	Equity	N/A	E	P / Party
Humansdorp District Hospital	20	DFBOT	R18.9m	E: 90 G: 10 D: 80 E: 8	P / Party
Head Office Accommodation	25	DFBOT	R870m	Gr: 12	P / Party
Cradle of Humankind	10	DBOT	N/A	E:100	P / Party
Social Payment Grant System	3	DFO	R260m	E:100	P / Party
Fleet Management / Cape	5	DFO	R553m	D: 100	P / Party

**Table 2B:** Short profile of PPP projects – Type II.

PPP Project	Duration (Years)	PPP Model	Investment Level	Financing Structure (%) **	Risk Allocation
<b>Type II*</b>					
N4 Toll Road –JBG to Maputo	30	DFBOT	R3b	E: 20 D:80	Shared
Correctional Facilities in SA	25	DFBOT	R1.7b	N/A	P / Party
N3 Toll Road – JHB to Durban	30	DFBOT	R3.5b	E: 85 D:15	P / Party
Queenstown Water Concession	N/A	N/A	N/A	N/A	N/A
Nelspruit Water Concession	N/A	N/A	N/A	N/A	N/A
Ilembe Water Concession	30	DBOT	R18m	N/A	P / Party

\* Type II PPP projects attained closure before promulgation of the Municipal Finance Management Act (MFMA) in 1999.

\*\* E = Equity; D = Debt; G = Gov; Gr = Grant, N/A = Data Not Available

## FINDINGS

Theoretical propositions formulated were subjected to empirical tests in the study, which revolved around the set of hypotheses. Table 3 presents a summary of the findings.

Survey respondents rated the various categories of statements relative to a five point scale: never to always relative to frequency, and strongly disagree to strongly agree relative to concurrence. Mean scores (MSs) were computed for each statement to enable interpretation of the percentage responses to determine the measure of central tendency.

Theoretical Proposition 1 - Costs and Affordability: Given that the mean scores are all  $> 3.40 \leq 4.20$ , the occurrences of the related manifestations and outcomes can be deemed to be between sometimes to often / often.

Theoretical Proposition 2 - Budget: Given that the two mean scores are both  $> 4.20 \leq 5.00$ , the degree of concurrence relative to the statements can be deemed to be between agree to strongly agree / strongly agree.

Theoretical Proposition 3 - Risk Transfer: The three mean scores  $> 3.40 \leq 4.20$  indicate that the degree of concurrence relative to the statements can be deemed to be between neutral to agree / agree, and the two mean scores  $> 4.20 \leq 5.00$ , indicate that the degree of concurrence relative to the statements can be deemed to be between agree to strongly agree / strongly agree.

Theoretical Proposition 4 - Policy and Regulatory Framework: The mean score  $> 2.60 \leq 3.40$  indicates that the degree of concurrence relative to the statement can be deemed to be between disagree to neutral / neutral. The ten mean scores  $> 3.40 \leq 4.20$  indicate that the degree of concurrence relative to the statements can be deemed to be between neutral to agree / agree, and the two mean scores  $> 4.20 \leq 5.00$ , indicate that the degree of concurrence relative to the statements can be deemed to be between agree to strongly agree / strongly agree.

Theoretical Proposition 5 – Project Management: Given that the one mean score is  $> 3.40 \leq 4.20$ , the degree of concurrence relative to the statement can be deemed to be between neutral to agree / agree. The other mean score  $> 4.20 \leq 5.00$  indicates that the degree of concurrence relative to the statement can be deemed to be between agree to strongly agree / strongly agree.

Theoretical Proposition 6 – PPP Awareness and Training: Given that the one mean score is  $> 3.40 \leq 4.20$ , the degree of concurrence relative to the statement can be deemed to be between neutral to agree / agree. The other mean score  $> 4.20 \leq 5.00$  indicates that the degree of concurrence relative to the statement can be deemed to be between agree to strongly agree / strongly agree.

The slow deal flow for PPP projects is due to capacity constraints in provincial governments and municipalities. Inadequate project management approach slows down the implementation of PPP projects. These findings were as expected.

The various PPP implementing agencies are always able to afford project transaction costs, given that they are subsidised in South Africa. Respondents strongly agree that the use of PPPs delivers benefits due to budget restrictions in the public sector

capital budgets. The findings also support the argument that PPP procurement brings forward investment and/or ensures that optimal maintenance strategies are followed.

Risk Management: Respondents generally agree that it is clear where risk lies in their PPP projects and that there is evidence of PPP actors seeking to shift risk to either party after signing contracts.

Policy Framework and Guidelines: According to the findings, an effective, credible and sustainable legal and regulatory framework is essential for promoting and fostering successful PPPs in South Africa for the implementation of PPP projects. Respondents concurred that the government is committed to private sector participation in local economic development through PPPs and further concurred that existing policy framework environment supports open market access.

PPP awareness and training: The majority of respondents agreed that lack of PPP training and awareness hampers PPP growth and development, while some felt that the level of PPP awareness and training within the public and private sectors in South Africa is sufficient for PPP development and growth.

**Table 3:** Frequency of theoretical proposition.

Theoretical Proposition	MS
<b>1: Costs and Affordability</b>	
PPP procurement delivers overall cost savings in comparison to conventional procurement.	4.08
Cost savings can be assessed with reference to factual data, rather than through comparisons with the assumptions used in the Public Sector Comparators.	3.50
The various PPP implementing agencies are able to afford project transaction costs.	4.08
PPP transaction costs are subsidised in South Africa.	3.81
High transaction costs are a major constraint for faster deal flow.	3.55

**Table 4:** Degree of concurrence relative to theoretical propositions.

Theoretical Proposition	MS
<b>2: Budget</b>	
The use of PPPs delivers benefits due to budget restrictions in the public sector capital budgets.	4.41
PPP procurement brings forward investment and / or ensures that optimal maintenance strategies are followed.	4.75

Continued overleaf...

Table 4: Degree of concurrence relative to theoretical propositions. (Continued)

Theoretical Proposition	MS
<b>3: Risk Transfer</b>	
Successful PPPs require existence of an adequate risk management system for appropriate transfer of risks to the party best suited to manage it at least cost.	4.50
PPP risk management training and awareness is necessary to ensure that project risks are adequately identified and mitigation strategies are followed.	4.52
Risk is transferred in practice.	4.17
It is always clear where risk lies in a PPP project.	3.66
There is evidence of contractors or customers seeking to shift risk onto the other party after signing the contract.	3.75
<b>4: Policy and Regulatory Framework</b>	
Existence of an effective and sustainable legal and regulatory framework is essential for promoting and fostering successful PPPs.	4.50
A credible legal and regulatory framework exists in South Africa for the implementation of PPP projects.	4.33
The government is committed to private sector participation in infrastructure development and service delivery.	4.08
The existing policy framework environment supports open market access and fair PPP competition.	3.75
PPPs protect public interest and maximise value added for projects.	4.16
The existing investment climate in South Africa promotes a viable and sustainable PPP project system.	4.08
Current PPP guidelines in South Africa provide adequate opportunity to assess the most effective type of PPP for a given project.	3.83
The policy environment favours PPP growth in South Africa.	3.50
Policies relative to PPPs are consistent with other government policies i.e. land use, social policies etc.	3.33
There is sufficient legislative authority for entering into PPP agreements.	3.91
There is sufficient legislation to support the management and supervisory role of the public sector in PPPs.	3.83
There are sufficient authorisations and leeway to enter into debt agreements by the PPP agencies.	3.66
Existing PPP regulations and guidelines provide for an efficient and effective mechanism for the procurement, management and auditing of PPP projects in South Africa.	3.92
<b>5: Project Management</b>	
The slow deal flow for PPP projects in South Africa is due to capacity constraints in provincial governments and municipalities.	4.25
Lack of or an inadequate project management approach slows down the implementation of PPP projects	4.08
<b>6: PPP Awareness and Training</b>	
Lack of PPP training and awareness hamper PPP growth and development	4.25
The level of PPP awareness and training within the public and private sectors in South Africa is sufficient for PPP development and growth.	4.08

## CONCLUSIONS

- There is a lack of institutional capacity within provincial and local government officials to successfully identify, analyse, structure, tender, evaluate, contract, and regulate PPPs.
- Affordability and budget constraints of implementing agencies is an impediment to PPP development.
- The investment level in South African PPP projects varies widely between R18.9m for Service Contracts to R5b for Infrastructure development projects.
- 50% of PPP projects represent service contracts, 41.7% represent Design Finance Build Operate Transfer (DFBOT), and 8.3% represent Joint Ventures.
- Responsibility transfer is mainly to the public sector.
- Risk is mainly transferred to the private sector.
- Existing policy and guidelines are sufficient for the promotion of an effective and sustainable PPP system.
- The level of PPP awareness and training within the Public and Private sectors in South Africa is not sufficient for the development and growth of PPP projects.
- PPP contracts surveyed seem to be performing well in relation to asset and service provision.

## RECOMMENDATIONS

- PPP awareness and training within the public and private sectors in South Africa should be intensified and rolled out to all PPP actors and end users as an alternative multi-purpose vehicle for infrastructure development and service delivery.
- PPP performance surveys should be conducted on a yearly basis, preferably twice, so that trend analysis results can inform decision makers and management for effective monitoring and control.
- Risk management should ensure a fair allocation and monitoring system for risks to avoid the tendency to transfer risks after contracts have been signed.
- It is recommended that the PPP Unit commissions sector specific studies that seek to compare performance across PPP and non-PPP contracts.

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# KEY ASPECTS OF CORROSION PROTECTION

by Bob Wilmot, Hot Dip Galvanisers Association Southern Africa

## CORROSION OF CARBON STEEL

Refined iron and carbon steel, extracted from their natural states of iron ore (iron oxide), have a fundamental tendency, unless adequately protected, to reverse the process and return, at various stages of degradation, to their natural states, commonly referred to as rust or Ferrous Oxide.

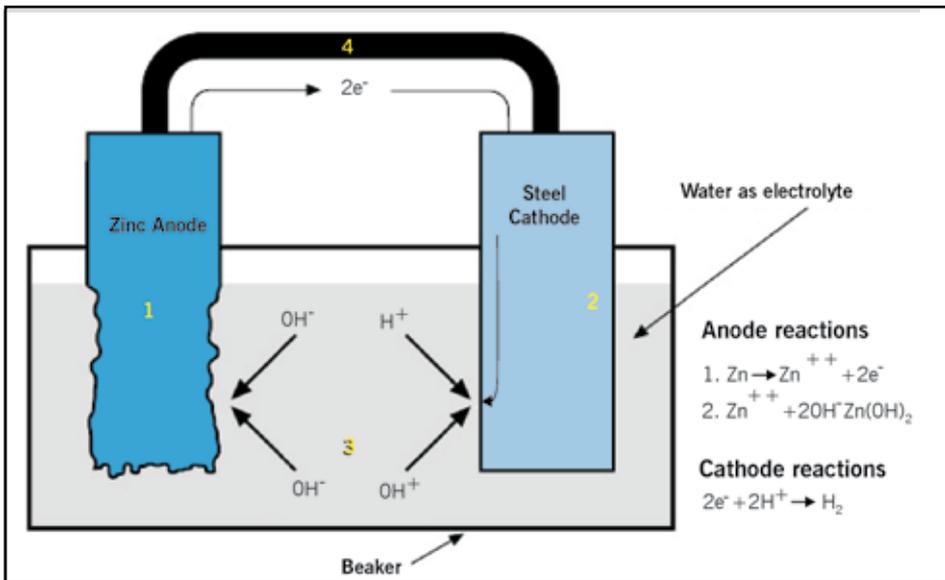
Corrosion can broadly be defined as the destruction or degradation of refined iron or carbon steel through their interaction with the environment in which they are required to function. In time, corrosion usually compromises the functional integrity of the materials ultimately leading to the inability of such materials to perform the functions for which they were originally designed.

For carbon steel to corrode four physical factors are present in what is generally called a **Metallic Corrosion Cell**, also referred to as **Bimetallic Couple**, or **Galvanic Corrosion** (see Figure 1). Removing or changing any one of these four factors will prevent or retard the rate at which the corrosive elements in the environment attack carbon steel.

Figure 1:

Bi-metallic Couple or corrosion cell using two dissimilar metals. Four elements must be present in order for a corrosion cell to exist:

1. Anode, in this example zinc
2. Cathode, shown as carbon steel
3. Electrolyte, or the environment
4. External electrical circuit



Transposing this 'laboratory type' example to a piece of corroding steel on which a droplet of rainwater is present, we get the representative diagram illustrated in Figure 2.

The anodes and cathodes result from differences in electrical potential within the steel composition. They alternate with time and general corrosion of a steel surface is the result. The rainwater droplet (green in the diagram) represents the electrolyte.

We use the physical nature of the corrosion cell as a weapon to combat corrosion. The specific materials used in the defensive system are Zinc (Zn) as the anode (1) that will 'sacrifice' itself to protect the Carbon Steel (Fe) or cathode (2). The electrolyte (3) is provided by the corrosive elements contained within a defined environment. The fourth (4) component of the corrosion cell is the electrical contact between the anode and cathode.

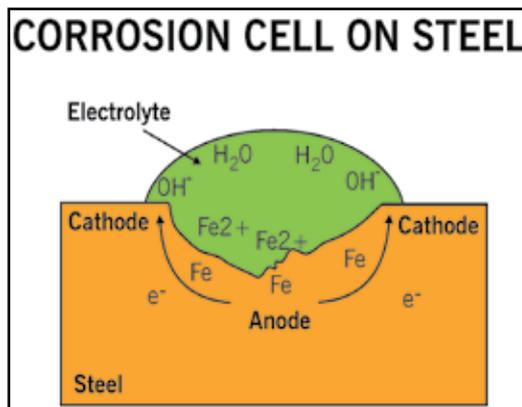


Figure 2: Diagram of a droplet of rainwater on carbon steel.

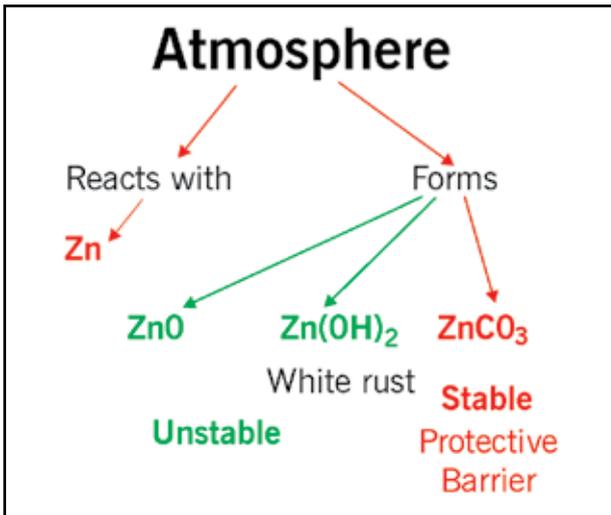
In order to influence the corrosion process we need to interrupt or influence one or more of these four components. Most corrosion control systems rely on the interruption of the external electrical circuit by placing a barrier between the anode and the cathode or between the cathode and the electrolyte. This is referred to as 'Barrier Protection'.

Corrosion control is essential for the economic utilisation of carbon steel. Provision of the appropriate protective coating can generate initial savings, and will result in a reduction in, or elimination of, maintenance and corresponding downtime, and will defer the replacement date of structures and equipment.

In suitable applications, hot dip galvanizing provides ideal corrosion control for carbon steel – no other coating matches galvanizing's unique combination of low first cost, ease of inspection for coating quality, durability, predictable performance, low maintenance, and resistance to abrasion and mechanical damage.

## HOW DOES ZINC PROTECT?

The corrosion protection of hot dip galvanizing (zinc) results from the formation of a dense insoluble corrosion product on the surface of the coating. Depending on the steel's chemical composition, particularly the amount of silicon and phosphorous, newly galvanized steel will have surface finishes ranging from bright shiny to dull grey matt. Over time, all zinc surfaces oxidise to zinc oxide ( $ZnO$ ), zinc hydroxide ( $Zn(OH)_2$ ) depending on the moisture content of the atmosphere and finally to an insoluble dense zinc carbonate ( $ZnCO_3$ ) layer. The first two products of corrosion, ( $ZnO$  &  $Zn(OH)_2$ ) are unstable and easily removed. The  $ZnCO_3$  layer by contrast, is stable, not easily removed, matt grey in colour and it is this stable layer that forms the required 'Barrier Protection' for corrosion control.



**Figure 3:** Chemical reaction of pure zinc with the atmosphere being oxygen, moisture and carbon dioxide

Products of corrosion formed are zinc oxide, zinc hydroxide and zinc carbonate.

It is therefore of paramount importance that a freshly galvanized surface is allowed to 'weather' and form its zinc carbonate protective barrier protection. Although the  $ZnCO_3$  is slowly removed, it is replaced by the continual supply of corrosion products as outlined above. Zinc is therefore referred to as a wasting material in that the zinc carbonate layer corrodes very slowly. It follows that the thicker the coating the longer the resulting service life provided for the carbon steel component.

Should an exposed area of steel occur, the zinc surface will preferentially corrode at a slow rate and protect the steel. This preferential protection is termed cathodic protection and, where damage is small, the protective corrosion products of zinc will fill the exposed area, re-establishing the barrier protection.

Finally, in addition to the barrier protection afforded, zinc protects against under-film creep (attack under the coating) should mechanical damage be so severe as to expose the underlying steel. Under-film creep is a common failure mechanism with pure barrier protection, (no cathodic protection) where rust spreads from any damaged area.

### Cathodic Protection

When two dissimilar metals are in electrical contact with each other, within an electrolyte, a small electrical voltage appears between them. Electrons flow to and from the dissimilar metals; one of the metals (anode) corrodes in preference to the other (cathode). This is called cathodic protection of the cathode by the anode. In other words, we use the physics of the corrosion cell (bi-metallic couple) as a weapon to combat the onset of corrosion of the material that we use for our steel structures.

The corroding metal is electro-negative (zinc) to the other metal (carbon steel). This behaviour is fundamental physics, so it is possible to predict which metals will provide cathodic protection

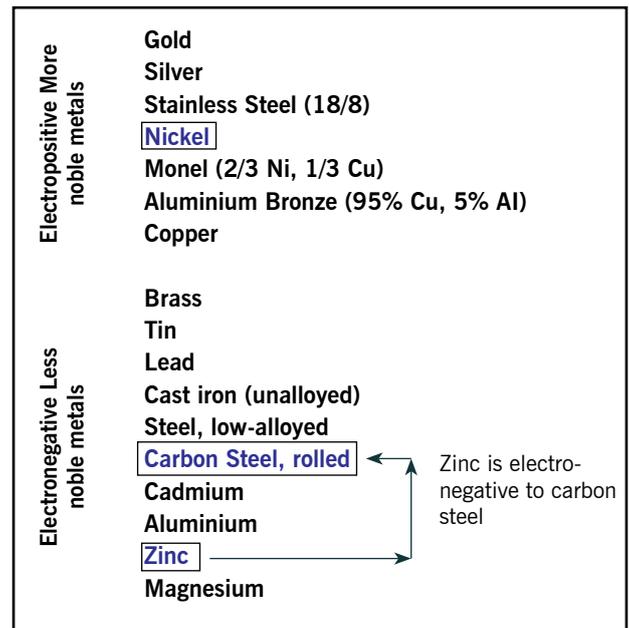
of other metals. Figure 4 lists a selected number of these metals and is used to explain why zinc will 'sacrifice' itself in order to protect carbon steel. The metals that are electro-negative to steel or will electrochemically protect (cathodic protection) iron or carbon steel are magnesium, aluminium, cadmium and of course zinc. Of these, zinc is the most economical and practical for the use in the hot dip galvanizing process.

Other metals such as nickel, copper and brass, i.e. electro-positive to steel, are used in electro-plating. Should the barrier protection afforded by these metal coatings be perforated (pinholes) the steel (iron) will corrode in order to protect the more noble (electro-positive) metal coating. This will be evidenced by what we refer to as corrosion creep under the protective coating.

### Electrochemical Protection

Generally we refer to electrochemical protection as 'sacrificial protection'. This is because the zinc will sacrifice itself in order to protect the steel to which it is alloyed. It will continue to do this almost to the last atom of zinc. As long as some zinc or zinc iron alloy remains, even though it is in poor condition, after many maintenance free years, the underlining steel will retain its structural integrity. No non-zinc coating can offer this benefit. Scratch type damage to the hot dip galvanized coating is often filled by oxides and carbonates formed from the zinc, tending to heal the damage and retard the rate of further corrosion.

A degree of sacrificial protection is provided by zinc rich paint, but this diminishes within 80 days. Such sacrificial protection will not be provided throughout the life of the coating, as is the case with hot dip galvanizing.



**Figure 4:** Galvanic Series of Metals also known as the nobility of metals.

## DESIGN FOR HOT DIP GALVANIZING

When designing and fabricating components suitable for hot dip galvanizing, implementing a few simple rules will result in a quality corrosion control system. The requirements are detailed on the Association's web site, ([www.hdgasa.org.za](http://www.hdgasa.org.za)) and illustrated by the examples on page 29. Design and fabrication are required to conform to normal standards, which apply regardless of whether a hot dip galvanized or any other form of corrosion protection system is used. In the case of hot dip galvanizing there are additional design and fabrication requirements to avoid distortion and aid access (filling) and drainage of molten zinc during galvanizing. In certain fabrications, holes that are present for other purposes may fulfil the requirements of venting air and filling and draining zinc. In other cases it might be necessary to provide additional holes for this purpose.

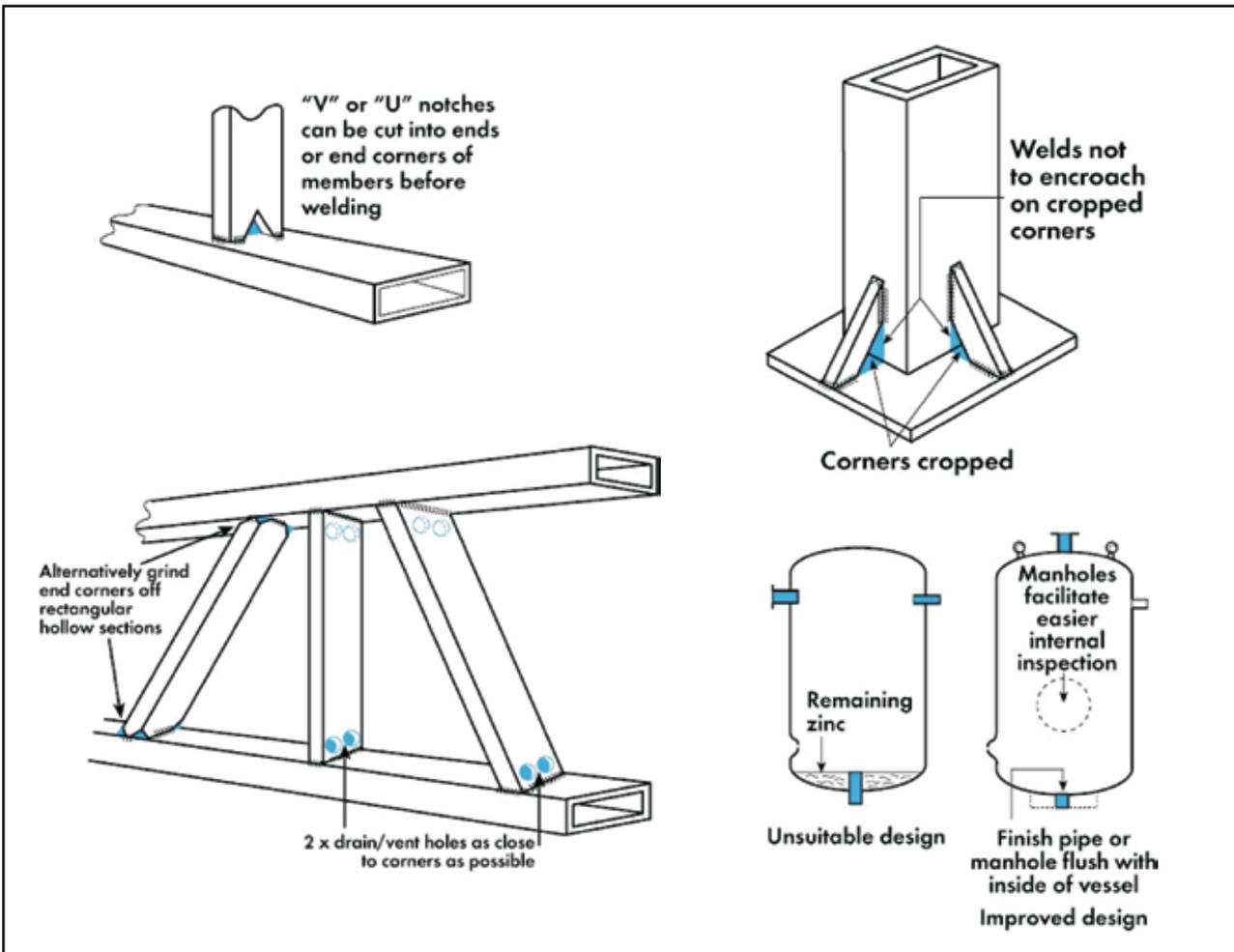


Figure 5: Examples of venting and drainage requirements.

## HOT DIP GALVANIZING PROCESS

Hot dip galvanized coatings are produced by a metallurgical reaction between iron (steel) and the coating material, being molten zinc. A series of hard, abrasion resistant iron/zinc alloys are formed and these are over coated with relatively pure zinc. The alloy layers supply an adherent coating that is harder than the underlying steel, providing good resistance against wear and mechanical damage. The coating thicknesses at sharp corners are maintained, thus providing excellent protection over areas that would otherwise have minimum coatings as provided by other systems.

The various layers play a significant role in the provision of corrosion control. For the coating to form, the steel surface is required to be totally free from all contaminants such as mill scale, rust, grease and oil. A fundamental requirement is that **'If the steel is not clean, it will not galvanize'**.

The hot dip galvanizing process entails dipping or immersing steel components into a series of cleaning pre-treatment chemicals, prior to immersing them into molten zinc, which is usually operated at 450°C. A major advantage of the process is that all steel surfaces are wetted uniformly, including areas that would be inaccessible for cleaning and coating by other methods.

### Duplex Coatings

The term 'duplex coating' was introduced by Sir Jan van Eijnsbergen of the Dutch Hot Dip Galvanizing Institute in the early fifties. The system was developed specifically for corrosion protection of steel structures used in the highly corrosive environments of the tulip growing hot houses. The term duplex coating describes

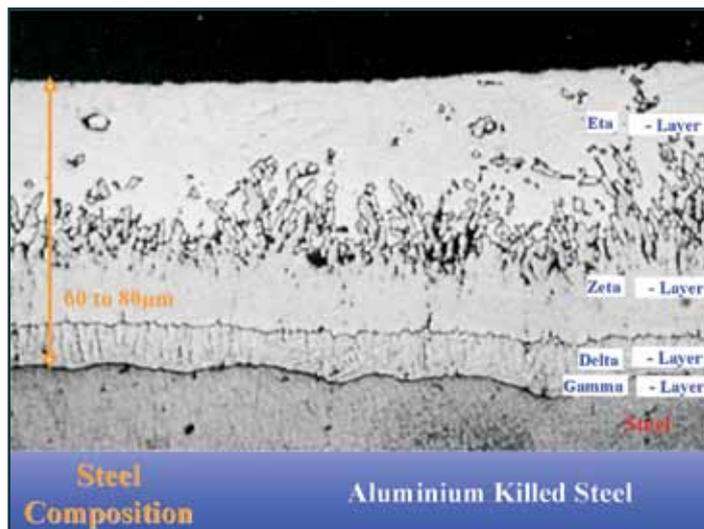


Figure 6: Hot dip galvanized coating x 200 micrograph.

the protection of steel by hot dip galvanizing and the additional 'barrier protection' i.e. coating with a suitable organic paint system. The purpose is to provide corrosion protection in highly corrosive environments, and include other benefits such as visibility, camouflage, or when an aesthetic appearance is required, various colour combinations.

The durability of the combined hot dip galvanized substrate and top organic coating system is greater than the sum of the separate durabilities of the two processes on the steel substrate. The syn-

ergistic effect can be estimated mathematically as follows:

$$\text{Duplex life} = \text{factor} \times (\text{zinc life} + \text{paint life})$$

The synergy factors vary from 1.4 in extreme corrosive environments to 2,7 in less-aggressive environments. For example, where hot dip galvanizing on its own would last approximately 15 years and paint on its own 10 years, the duplex system would give a service life of 35 years and not 25 years, i.e.

$$1.4 \times (15 \text{ years} + 10 \text{ years}) = 35 \text{ years}$$

The reasons for this synergistic effect are as follows.

Paint systems are all, to a greater or lesser degree, permeable, allowing moisture, oxygen and pollutants to diffuse through a paint coating and attack the steel. Red rust forms at the steel surface i.e. at the interface between the steel surface and top paint system. Since rust (a mixture of various hydrated iron oxides with varying compositions) has a volume, which is approximately twice that of the steel from which it has been formed, the paint coating will lose contact with the substrate and, depending on its adhesion and cohesion, will start to crack and/or flake off.

In addition, corrosion creep under the paint will occur and result in 'blistering' and further flaking of the adjoining protection paint, thus exposing more steel to further corrosion. When steel is hot dip galvanized, a metallurgical bond between the impervious metal zinc coating and the steel is formed. This guarantees sound adhesion and a firm base for the paint system. The penetration of moisture, oxygen and pollutants to the hot dip galvanized/paint interface causes the zinc or the more corrosion resistant zinc/iron alloy layers to corrode slowly. However, these zinc corrosion products (mainly zinc oxide and zinc hydroxide) have a volume, which is only 15-20% more than the volume of zinc from which they have been formed. These zinc corrosion products will seal off small pores, craters or cracks in the top paint coating, thus re-establishing the 'barrier protection' properties of the system. It is by this process that hot dip galvanizing and a suitable paint coating complement each other and provide the synergistic properties of the overall coating. For all coating systems, preparation of the surfaces to be protected is of paramount importance for successful corrosion control.

The adhesion of hot dip galvanizing to steel is provided by metallurgical laws, whereas adequate preparation of the hot dip galvanized surface onto which the paint is to be applied is of paramount importance to ensure long-term adhesion.

## FASTENERS (BOLTS & NUTS)

Corrosion protection of carbon steel fasteners is generally achieved through the application of a coating (barrier protection), be it in the form of a paint system or through the use of a metallic coating. Metallic coatings comprise different materials, though zinc is usually chosen for reason of economics, ease of application and its mechanism of cathodic protection.

Zinc is applied either by an electroplating process (electro-galvanizing) or by immersion in molten zinc (hot dip galvanizing). Corrosion protection provided by zinc is generally proportional to the coating thickness, i.e. the thicker the coating the longer the service life. Zinc coating thicknesses achieved using the electroplating process, generally range between  $6\mu\text{m}$  and  $10\mu\text{m}$  ( $\mu\text{m}$  = micro metres), while hot dip galvanized coating thicknesses range from  $45\mu\text{m}$  to about  $65\mu\text{m}$ . It is therefore imperative to specify the specific type of zinc coating required for corrosion protection. The word 'galvanized' alone is insufficient and should be avoided. Corrosion protection specifications should clearly state, 'electro-plated, or electro-galvanized' or 'hot dip galvanized'.

The following specification is restricted to the requirements for Hot Dip Galvanized carbon steel fasteners, comprising bolts, nuts and washers.

## REPAIR TO SMALL DEFECTS

Occasionally, site repairs through welding or cutting are necessary, but it is recommended that a single repair area be kept to a minimum, ideally less than  $10\text{cm}^2$ . The total repaired surface area should not exceed 0.5% of the component's total area. In terms of SANS 121 (ISO 1461:1999), a coating may be repaired either by zinc thermal metal spraying, zinc rich epoxy or a zinc

rich paint. The repaired surface must have a coating thickness of an additional  $30\mu\text{m}$  more than that required in terms of the specification.



**Figure 7:** Zinc thermal spray is an ideal method of hot dip galvanising repair. Surfaces to be repaired must be cleaned and the zinc coating applied to  $30\mu\text{m}$  over and above that specified in terms of SANS 121 (ISO 1461: 1999).



**Figure 8:** Zinc Fix consists of 100 grams of zinc rich epoxy. Once the activator is mixed the contents must be used within 30 minutes. Zinc fix was specifically developed as a site repair kit for galvanizing.

## SERVICE LIFE PERFORMANCE

As with all corrosion protection coating systems, the service life of the product depends on two basic considerations, viz, the type of coating and, as important, the environment in which the coating is designed to operate.

## CONCLUSION

Hot dip galvanizing, similar to paint and electro-plated products, provides barrier protection as the 1st line of defence. Zinc, being electro-negative to carbon steel, provides cathodic protection or a 2nd line of defense when used as the coating material. Unlike other zinc coatings, hot dip galvanizing follows metallurgical laws and binds the coating metallurgically (chemically) to the carbon steel, achieving far greater coating thicknesses. Thicker coatings lead to longer service life, greater use of resources and a greater potential for recycling materials. This adds up to a cost effective use of the country's natural resources, which in turn lessens the impact on the environment. Consider the economic cost and environmental impact involved in producing one ton of steel: By the correct application of hot dip galvanizing to steel structures we can extend the useful service life of steel by three to five times, with a corresponding saving in finance and the environment.

**Table 1:** Atmospheric corrosive environments classified in terms of ISO 9223.

Class	Description	Corrosion rate (av. loss for Zn $\mu\text{m}/\text{y}$ )	Typical life in yrs to 1st maintenance (Z275 $\pm 20\mu\text{m}$ )	Typical life in yrs to 1st maintenance (85 $\mu\text{m}$ Zn in HDG)	Typical life in yrs of a DUPLEX system
C1	Interior: dry	= 0.1	200	>200+	Not required
C2	Interior: occasional condensation Exterior: exposed rural inland	0.1 to 0.5	40 to 200	>170	Not required
C3	Interior: high humidity, some air pollution Exterior: urban inland or mild coastal	0.5 to 2	10 to 40	42 to 170	Not required
C4	Interior: swimming pools, chemical plant, etc. Exterior: industrial inland or urban coastal	2 to 4	5 to 10	21 to 42	42 to 84
C5	Exterior: industrial with high humidity or high salinity coastal	4 to 8	3 to 5	10 to 21	18 to 37

## THE HOT DIP GALVANIZERS ASSOCIATION STRATEGIC OBJECTIVES

The Hot Dip Galvanizers Association of Southern Africa was founded in 1965 and is constituted by its membership to promote a higher level of acceptance and confidence in the application of hot dip galvanizing and Duplex coating systems, as an appropriate means of providing corrosion protection of carbon steel structures.

The Hot Dip Galvanizers Association Southern Africa is simultaneously an independent advisory body, and objective authority, representing the interests of end-users, consumers and specifiers of hot dip galvanized and Duplex coated carbon steel products that require long term service life performance.

The Association provides users and specifiers with the appropriate technical information for correctly employing hot dip galvanizing as an appropriate means of providing long term service life to various forms of carbon steel structures in various corrosive environments. This is achieved through the application of the following objectives:

- General technical presentations and market promotional activities.
- Focused technical marketing support within the corrosion protection industry.
- Training and educational programmes, such as skills development, inspector training courses and technical presentations to Technicians and Universities.

### PUBLICATIONS AVAILABLE FROM THE ASSOCIATION

- Association Journal – Hot Dip Galvanizing Today. (Free publication produced quarterly).
- Steel Protection by Hot Dip Galvanizing and Duplex Systems.
- Practical Guidelines for the Inspection and Repair of Hot Dip Galvanized Coatings.
- Specification for the Performance Requirements of Duplex Coating Systems.
- Code of Practice for Surface Preparation and Application of Organic Coatings Applied to Hot Dip Galvanized Steel.
- Guidelines for the Use of Hot Dip Galvanized Products in the Mining Industry.
- Wall Chart – “Design for Hot Dip Galvanizing”, which provides quality data relating to specifications.
- Directory for Specifiers and Buyers.
- Guidelines for Buried Hot Dip Galvanized Piping.
- Guidelines for the Use of Hot Dip Galvanized Piping for Water Conveyance.
- Case Studies and Information sheets, visit the web site [www.hdgasa.org.za](http://www.hdgasa.org.za) for details.



