HARDWARE, SOFTWARE AND PEOPLEWARE

SAICSIT 2001

Edited by
Karen Renaud
Paula Kotzé
Andries Barnard
HARDWARE, SOFTWARE AND PEOPLEWARE

South African Institute of Computer Scientists and Information Technologists Annual Conference
25 – 28 September 2001
Pretoria, South Africa

Edited by Karen Renaud, Paula Kotzé & Andries Barnard
University of South Africa, Pretoria
# Table of Contents

**Message from the SAICSIT President** ................................................ iv  
**Message from the Chairs** ................................................................... vi  
**Conference Organisation** ................................................................... vii  
**Referees** ............................................................................................. viii

## Keynote Speakers

- *Cyber-economies and the Real World* ................................................. xi  
  Alan Dix  
- *Computer-aided Instruction with Emphasis on Language Learning* .............. xiv  
  Lut Baten  
- *Internet and Security Trends* ................................................................. xv  
  Arthur Goldstuck  
- *The Future of Data Compression in E-technology* ..................................... xvi  
  Nigel Horspool  
- *Strategic Planning for E-Commerce Systems: Towards an Inspirational Focus* ...... xvii  
  Raymond Hackney

## Research Papers

### Human-Computer Interaction / Virtual Reality

- *The Development of a User Classification Model for a Multi-cultural Society* .......... 1  
  M Streicher, J Wesson & A Calitz  
- *Real-Time Facial Animation for Virtual Characters* ......................................... 11  
  D Burford & E Blake  
- *The Effects of Avatars on Co-presence in a Collaborative Virtual Environment* .......... 19  
  J Casanueva & E Blake

### Education

- *Structured Mapping of Digital Learning Systems* ........................................... 29  
  E Cloete & L Miller

### Formal Methods

- *The specification of a multi-level marketing business* ........................................ 35  
  A van der Poll & P Kotzé  
- *Finite state computational morphology - the case of the Zulu noun* ....................... 45  
  L Pretorius & S Bosch  
- *Combining context provisions with graph grammar rewriting rules: the three-dimensional case* ................................................................. 54  
  A Barnard & E Ehlers

### Human-Computer Interaction / Web Usability

- *Web Site Readability and Navigation Techniques: An Empirical Study* .................. 64  
  P Licker, R Anderson, C Macintosh & A van Kets  
- *Jiminy: Helping Users to Remember Their Passwords* ...................................... 73  
  K Renaud & E Smith

### Information Security

- *Computer Security: Hacking Tendencies, Criteria and Solutions* ....................... 81  
  M Botha & R von Solms  
- *An access control architecture for XML documents in workflow environments* ........ 88  
  R Botha & J Eloff
Graphics and Ethics
Model-based Segmentation of CT Images .......................................................... 96
O Marte & P Marais
Towards Teaching Computer Ethics .................................................................... 102
C de Ridder, L Pretorius & A Barnard

Human-Computer Interaction / Mobile Devices
Ubiquitous Computing and Cellular Handset Interfaces – are menus the best way forward? ........................................................................................................... 111
G Marsden & M Jones
A Comparison of the Interface Effect on the Use of Mobile Devices .................. 120
J Franken, A Stander, Z Booley, Z Isaacs & R Rose
The Effect of Colour, Luminance, Contrast, Icons, Forgiveness and Closure on ATM Interface Efficiency ............................................................... 129
A Stander, P van der Zee, & Y Wang

Object Orientation
JavaCloak - Considering the Limitations of Proxies for Facilitating Java Runtime Specialisation ................................................................. 139
K Renaud

Hardware
Hierarchical Level of Detail Optimization for Constant Frame Rate Rendering ...... 147
S Nirenstein, E Blake, S Windberg & A Mason
A Proposal for Dynamic Access Lists for TCP/IP Packet Filtering .................... 156
S Hazelhurst

Information Systems
The Use of Technology to Support Group Decision-Making in South Africa ....... 165
J Nash, D Gwilt, A Ludwig & K Shaw
Creating high Performance I.S. Teams ............................................................... 172
D C Smith, M Becker, J Burns-Howell & J Kyriakides
Issues Affecting the Adoption of Data Mining in South Africa .......................... 182
M Hart, E Barker-Goldie, K Davies & A Theron

Information Systems / Management
Knowledge management: do we do what we preach? .................................... 191
M Handzic, C Van Toorn, & P Parkin
Information Systems Strategic Planning and IS Function Performance:
An Empirical Study ......................................................................................... 197
J Cohen

Formal Methods
Implication in three-valued logics of partial information .................................... 207
A Britz
Optimal Multi-splitting of Numeric value ranges for Decision Tree Induction .. 212
P Lutu
Abstracts of Electronic Papers

Lessons learnt from an action research project running groupwork activities on the Internet: Lecturers' experiences ................................................................. 221
T Thomas & S Brown

A conceptual model for tracking a learners' progress in an outcomes-based environment .............................................................. 221
R Harmse & T Thomas

Introductory IT at a Tertiary Level – Is ICDL the Answer? ......................... 222
C Dixie & J Wesson

Formal usability testing – Informing design .................................................. 222
D van Greunen & J Wesson

Effectively Exploiting Server Log Information for Large Scale Web Sites .......... 223
B Wong & G Marsden

E von Solms & J Eloff

A Pattern Architecture, Using patterns to define an overall systems architecture ........................................................................................................ 224
J van Zyl & A Walker

Real-time performance of OPC ....................................................................... 224
S Kew, & B Dwolatzky

The Case for a Multiprocessor on a Die: MoaD ............................................. 225
P Machanick

Further Cache and TLB Investigation of the RAMpage Memory Hierarchy .......... 225
P Machanick & Z Patel

The Influence of Facilitation in a Group Decision Support Systems Environment .. 226
T Nepal & D Petkov

Managing the operational implications of Information Systems ...................... 226
B Potgieter

Finding Adjacencies in Non-Overlapping Polygons ....................................... 226
J Adler, GD Christelis, JA Denyes, GD Konidaris, G Lewis, AG Lipson, RL Phillips,
DK Scott-Dawkins, DA Shell, BV Strydom, WM Trakman & LD Van Gool
Message from the SAICSIT President

The South African Institute of Computer Scientists and Information Technologists (SAICSIT) was formed in 1982 and focuses on research and development in all fields of computing and information technology in South Africa. Now in the 20th year of its existence, SAICSIT has come of age, and through its flagship series of annual conferences provides a showcase of not only the best research from the Southern-African region, but also of international research, attracting contributions from far afield. SAICSIT does, however, not exist or operate in isolation.

More than 50 years have passed since the first electronic computer appeared in our society. In the intervening years technological development has been exponential. Over the last 20 years there has been a vast growth and pervasiveness of computing and information technology throughout the world. This has led into the expansion and consolidation of research into a diversity of new technologies and applications in diverse cultural environments. During this period huge strides have also been made in the development of computing devices. The processing speed of computers has increased thousand-fold and memory capacity from megabytes to gigabytes in the last decade alone. The Southern African region did not miss out on these developments.

It is hardly possible for such quantitative expansion not to bring a change in quality. Initially computers had been developed mainly for purposes such as automation for the improvement of processing, labour-reduction in production and automation control of machinery, with artificial intelligence, which made great strides in the 1980s, seen as the ultimate field to which computers could be applied. As we moved into the 1990s it was recognized that such an automation route was not the only direction in the improvement of computers. The expansion of processing power has enabled image data to be incorporated into computer systems, mainly for the purpose of improving human utilisation. For most computer technologies of the 1990s, including the Internet and virtual reality, automation was not the ultimate purpose. Humans were increasingly actively involved in the information-processing loop. This involvement has gradually increased as we move into the 21st century. Development of computer technology based not on automation, but on interaction, is now fully established.

The method of interaction has significantly changed as well. The expansion of computer ability means that the same function can be performed far more cheaply and on smaller computers than ever before. The advent of portable and mobile computers and pervasive computing devices is ample evidence of this. The need for users to be at the same location as a computer in order to reap the benefits of software installed on that computer is becoming an obsolete notion. Time and space are no longer constraints. One of the most discussed impacts of computing and information technology is communication and the easy accessibility of information. This changes the emphasis for research and development – issues such as cultural, political, and economic differences must, for example, be accommodated in ways that researchers have not previously considered. Our goal should be to enable users to benefit from technological advances, hence matching the skills, needs, and expectations of users of available technologies to their immense possibilities.
The conference theme for the SAICSIT 2001 Conference – *Hardware, Software and Peopleware: The Reality in the Real Millennium* – aims to reflect technological developments in all aspects related to computerised systems or computing devices, and especially reflect the fact that each influences the others.

Not only has SAICSIT come of age in the 21st century, but so has the research and development community in Southern Africa. The outstanding quality of papers submitted to SAICSIT 2001, of which only a small selection is published in this collection, illustrates both the exciting and developing nature of the field in our region. I hope that you will enjoy SAICSIT 2001 and that it will provide opportunities to cultivate and grow the seeds of discussion on innovative and new developments in computing and information technology.

Paula Kotzé
SAICSIT President
Message from the Chairs

Running this conference has been rewarding, exciting and exhausting. The response to the call for papers we sent out in March was overwhelming. We received 64 paper submissions for our main conference and twelve for the postgraduate symposium. We had a panel of internationally recognized reviewers, both local and international. The response from the reviewers was impressive — accepting a variety of papers and mostly returning the reviews long before the due date. We were struck, once again, by the sheer magnanimity of academia — as busy as we all are, we still manage to contribute fully to a conference such as SAICSIT.

After an exhaustive review process, where each paper was reviewed by at least three reviewers, the program committee accepted 26 full research papers and 14 electronic papers. Five papers were referred to the postgraduate symposium, since they represented work in progress — not yet ready for presentation to a full conference but which nevertheless represented sound and relevant research. The papers published in this volume therefore represent research of an internationally high standard and we are proud to publish it. Full electronic papers will be available on the conference web site (http://www.cs.unisa.ac.za/saicsit2001/).

Computer Science and Information Systems academics in South Africa labour under difficult circumstances. The popularity of IT courses stems from the fact that IT qualifications are in high demand in industry, which leads in turn to a shortage of IT academic staff to teach the courses, even when posts are available. The net result is that fewer people teach more courses to more students. IT departments thus rake in ever-increasing amounts of state subsidy for their universities. These profits, euphemistically labelled “contribution to overhead costs”, are deployed in various ways: cross-subsidization of non-profitable departments; maintenance of general facilities; salaries for administrative personnel, etc. Sweeteners of generous physical resources for the IT departments may be provided. We have yet to hear of a University in South Africa where significant concessions have been made in terms of industry-related remuneration. At best, small subventions are provided. As a result, shortages of quality staff remain acute in most IT departments — especially at senior teaching levels. What is even worse is that academics in these departments have to motivate the value of their conference contributions and other IT outputs to selection committees, often dominated by sceptical academic power-brokers from the more traditional departments whose continued survival is underwritten by IT’s contribution to overhead costs.

The papers published in this volume are conclusive evidence of the indefatigability and pertinacity of Computer Science and Information Systems academics and technologists in South Africa. We are proud to be part of such a prestigious and innovative group of people.

In conclusion, we would like to thank the conference chair, Prof Paula Kotzé, for her support. We also specially thank Prof Derrick Kourie for his substantial contribution. Finally, to all of you, contributors, presenters, reviewers and organisers — a big thank you — without you this conference could not be successful.

Enjoy the Conference!
Karen Renaud & Andries Barnard

---

1 This taken almost verbatim from Professor Derrick Kourie’s SACLA 2001 paper titled: “The Benefits of Bad Teaching”.
Conference Organisation

General Chair
Paula Kotze

Programme Chairs
Karen Renaud
Andries Barnard

Organising Committee
Chairs
Lucas Venter, Alta van der Merwe

Art and Design
Tersia Parsons

Sponsor Liaison
Paula Kotze, Chris Bornman

Secretarial & Finances
Christa Prinsloo, Elmarie Havenga

Marketing & Public Relations
Klarissa Engelbrecht, Elmarie van Solms, Adriaan Pottas, Mac van der Merwe

Audio Visual
Tobie van Dyk, Andre van der Poll, Mac van der Merwe

Program Committee

Bob Baber – McMaster University, Canada
Andries Barnard – University of South Africa
Judy Bishop – University of Pretoria
Andy Bytheway – University of the Western Cape
Andre Calitz – University of Port Elizabeth
Elsabe Cloete – University of South Africa
Carina de Villiers – University of Pretoria
Alan Dix – Lancaster University, United Kingdom
Jan Eloff – Rand Afrikaans University
Andries Engelbrecht – University of Pretoria
Chris Johnson – University of Glasgow, United Kingdom
Paul Licker – University of Cape Town
Paula Kotze – University of South Africa
Derrick Kourie – University of Pretoria
Philip Machanick – University of the Witwatersrand
Gary Marsden – University of Cape Town
Don Petkov – University of Natal Pietermaritzburg
Karen Renaud – University of South Africa
Ian Sanders – University of the Witwatersrand
Derrick Smith – University of Cape Town
Harold Thimbleby – Middlesex University, United Kingdom
Theda Thomas – Port Elizabeth Technikon
Herna Viktor – University of Pretoria, South Africa
Bruce Watson – Universities of Pretoria and Eindhoven
Janet Wesson – University of Port Elizabeth
Referees

Molla Alemayehu  Klarissa Engelbrecht  Pekka Pihlajasaari
Trish Alexander  David Forsyth  Nelisha Pillay
Adi Attar  John Galletly  Laurette Pretorius
Bob Baber  Vashti Galpin  Karen Renaud
Andries Barnard  Wayne Goddard  Ingrid Rewitzky
John Barrow  Alexandre Hardy  Sheila Rock
Judy Bishop  Scott Hazelhurst  Markus Roggenbach
Gordon Blair  Johannes Heidema  Ian Sanders
Arina Britz  Tersia Hörne  Justin Schoeman
Andy Bytheway  Chris Johnson  Martie Schoeman
André Calitz  Bob Jolliffe  Elsje Scott
Charmain Cilliers  Paula Kotzé  Derek Smith
Elsabe Cloete  Derrick Kourie  Elmé Smith
Gordon Cooper  Les Labuschagne  Adrie Stander
Richard Cooper  Paul Licker  Harold Thimbleby
Annemieke Craig  Philip Machanick  Theda Thomas
Thad Crews  Anthony Maeder  Judy Van Biljon
Quintin Cutts  David Manlove  Alta Van der Merwe
Michael Dales  Gary Marsden  André van der Poll
Carina de Villiers  Thomas Meyer  Tobias Van Dyk
Alan Dix  Elsa Naudé  Lynette van Zijl
Dunlop Mark  Martin Olivier  Lucas Venter
Elize Ehlers  Don Petkov  Herna Viktor
Jan Eloff  
Andries Engelbrecht

Conference
Sponsors

UNISA  ABSA  Microsoft  NRF

ORACLE
Keynote Abstracts
Creating High Performance IS Teams

DC Smith, M Becker, J Burns-Howell, J Kyriakides

University of Cape Town, dsmit@commerce.uct.ac.za

Abstract The use of teams within organisations is becoming more prevalent as teams have been identified as an efficient work unit of human capital. This research identified 17 team effectiveness characteristics and, using a sample of local project team members, attempted to ascertain which of these factors distinguished highly performing IS teams from lower performing ones. A web-based survey was conducted and valid data collected from 62 IS professionals working in project teams. The results suggested that Goal Setting, Conflict Management, Skill Diversity/Heterogeneity, Commitment, Quality and Performance, Mutual Accountability, Trust and Support were significant characteristics in segregating high performance IS teams from those who achieved lower performance levels. These findings are of use to IS project managers who need to focus on all the 17 characteristics whilst placing particular emphasis on the 6 characteristics reported above.

Keywords: IS project teams, team effectiveness, team productivity, high-performing teams

Computing Review Categories: K.6.1

1. Introduction

Information Systems has arguably become the most influential force leading to the restructuring of: business, the way in which we socially communicate, and the political economy as a whole [26]. The IS function has become a source of not only competitive advantage but also one of strategic survival. Management now, more than ever, needs a way in which to create and manage more productive working units and environments.

Klenke [21] notes that many firms are discovering that teams may be the productivity breakthrough of the modern organisation. Research has shown that in many situations teams increase commitment, improve decision-making and encourage innovation [27,15].

Verma [32] classifies a project team as a work group of two or more individuals, united by a common purpose and shared responsibility who must interact and work interdependently with each other to accomplish project objectives. While this definition is simplistic, it does highlight the most critical aspects of a team – namely that all the individuals within the team have a common aim and that the jobs and skills of each member fit in with those of other members.

Studies within this field have identified those specific characteristics or factors that teams need in order to perform but it is not clear which of these factors drive or impede exceptional team performance in relation to the other factors [30].

This study argued that many Information Systems project teams are not performing at high levels of effectiveness. The intention of this study was to ascertain which of these effectiveness characteristics have a significant impact on the effectiveness of an IS team. Through developing a more complete understanding of these characteristics, management will be able to improve project team performance.

2. Literature Review

2.1 The Team Approach

Effective teamwork has been identified by researchers as one of the core values in high-performance organisations [12]. Companies that continue to perform successfully have cultures in which the concept of teamwork occupies a central position. Schuler [28] affirms that team-based approaches to work can increase innovation, improve quality, better serve customers and shorten the time it takes for accompany to transform an idea into a product that is viable within the marketplace.

Verma [32] classifies a project team as a work group of two or more individuals, united by a common purpose and shared responsibility who must interact and work interdependently with each other to accomplish project objectives. While this definition is simplistic, it does highlight the most critical aspects of a team – namely that all the individuals within the team have a common aim and that the jobs and skills of each member fit in with those of other members.
Katzenbach and Smith [20] and Walter and Walter [33] provide an extended definition of a team. They recognise the fact that team members hold themselves mutually accountable for the success of the group and the completion of the specified objectives of the project.

Katzenbach and Smith [20] also state that teamwork is most likely to manifest itself within behaviours such as listening, constructively responding, and supporting and recognising the abilities and achievements of others.

2.2 Team Development

Many authors believe that a team goes through various different and definable stages during its life cycle [for examples see 13,23,27,32,34].

The team performance curve shown in Figure 1 was developed by Katzenbach and Smith [20] and identifies the nature and definition of several classifications of individuals working together. They state that a group of individuals working together must make a choice as to whether they merely want to act as a working group or progress along the performance curve and become a team. Through deciding to move towards a higher effectiveness bracket, the team chooses to commit to interacting to a higher degree. This commitment offers significant rewards, both in the improvement of team effectiveness and a measurable increase in the potential performance impact the team may have on the organisation.

Alternatively, this commitment also results in the elevation of the risk of conflict amongst group members. They classify groupings of individuals, shown in Figure 1, into the following five categories:

The Working Group

Working groups are usually temporary groupings of people, assembled for a specific purpose that rely on the sum of individual bests for their performance [20,33]. Members share skills and knowledge in order to enable each individual to accomplish their designated tasks. Within the group, there is no collective incentive or motivation to extend the scope of these explicit tasks or to elevate the level of communication and thus forge a sense of group unity [20,33].
Pseudo Teams

Pseudo teams represent groups of people that have taken an affirmative decision to act as an integrated unit, yet are not really trying to achieve this goal. There remains no focus on collective performance or shared purpose within the team, resulting in pseudo teams contributing less to an organisation than working groups [33]. The overhead incurred by more thorough communication and the struggle to maintain the team facade obstructs the team members from being as productive as if they were working alone [20,29]. Katzenbach and Smith [20] describe this situation as the “sum of [the] whole [being] less than [the] individual parts”.

Potential Teams

Teams that recognise that they need to achieve a significant increase in performance in order to accomplish their allocated tasks, and actually attempt to do so are classified as potential teams [20]. Potential teams suffer from a lack of clearly defined goals, identity and purpose, but to a lesser degree than pseudo teams. Coupled with a low degree of responsibility amongst group members, the impact of potential teams within the organisation does not exceed that of a working group.

Real Teams

A real team is a realisation of the full definition of a team. The work-products they generate are well co-ordinated, result from combined effort and are of a high standard of quality [20]. In order to achieve this, real teams typically consist of a small number of highly committed, task-orientated, mutually accountable members [20,32]. The team has well-defined standards resulting in all members clearly understanding the joint goal and purpose, and the approach necessary to achieve these aims.

High Performance Teams

High performance teams significantly outperform all other teams as well as surpassing both the conceivable expectations of those both within and without the team. The members of such teams are committed not only to the purpose and goal of the team but also to each other’s personal growth and success. Although it is possible for potential and real teams to advance to the level of high-performance teams, many teams are unable to accomplish this [20].

2.3 Characteristics of High Performance Teams

As defined above, high performance teams distinguish themselves from other groupings of individuals by far exceeding expectations. Although there are no frameworks or models capable of guaranteeing that teams develop into high performance teams, numerous authors [for examples 5,6,9,11,20,28,30,32] have defined and documented what they believe to be the specific characteristics a team requires before it can be regarded as high-performing. These characteristics have been grouped and condensed into seventeen well-defined characteristics that are discussed individually.

1. Clear Goal(s) and Purpose

Goals exist at both an organisational and personal level. It is therefore necessary for high performance teams to accept the diversity of these goals and attempt to align them [30]. DeMarco and Lister [11] further emphasise this by stating, “the purpose of a team is not goal attainment but goal alignment”. If a goal is ambiguous or ill defined, the group will lack motivation and commitment. A team that lacks a clear understanding of its goal cannot fully contribute to the organisations strategic integrity [13].

2. Open Communication

Blanchard and Carew [5]; Larson and LaFasto [22]; and Schuler [28] state that a key criteria for team membership is the need to learn how to sell points of view both to each other and the organisation. This sharing of information should be respectful and team-centred. Verma [32] and Katzenbach and Smith [20] all believe that communication with these attributes leads to a clear sense of roles and expectations, greater team productivity, enhanced collaboration and problem solving, improved working relationships, greater job satisfaction, fewer destructive conflicts and a sense of personal achievement.

3. Identity and Work Approach

Identity is created through norms and rules. Verma [32] defines norms as the informal rules, expectations, and patterns of behaviour that teams establish and that are also accepted by team members. Norms are thus vital effectiveness factors as they govern the team interaction dynamic, which in turn impacts team effectiveness and performance [12,13,20,22,34].
4. External Relationship Management

External relationship management amalgamates all possible interactions between the team and the outside world including feedback, external search information and access to necessary resources. Verma [32] states that feedback helps team members to monitor themselves and encourages in-depth understanding of problems. If a team is to fulfil its role in the organisation, it must be given access to the relevant resources to do so. This access not only provides team members with a sense of responsibility, but the power necessary to accomplish its goals [6,16,20,28].

5. Constructive Conflict Management

According to De Vries [12], conflict within teams is inevitable. Based on this principle, Schuler [28] redefines conflict management as tension management, since instead of avoiding conflict, workers should learn to create constructive conflict and manage the resulting tension effectively. In high-performance teams, members go to great lengths to resolve differences between themselves while maintaining individual self-respect. Conflict results in collaboration as conflicting opinions lead to creative problem solving [2,12]

6. Individuality

De Vries [12] regards teamwork as an interesting balancing act. It is a form of participation that can flourish only in an atmosphere that encourages individual freedom and creative opportunity under the umbrella of overall organisational goals [18,12]. Teamwork therefore aims to provide an interdependent balance between the needs of the individual and the needs of the organisation [12].

7. Roles

Francis and Young [13] define roles as the explicit definition of the contribution that a person makes to his or her team. Research [13,18,30,32] suggests that the definition of roles within a team is a necessary factor when examining the effectiveness of a team. As with goals, roles need to be properly defined and allocated along with the necessary resources.

8. Skill Diversity/Heterogeneity

Katzenbach and Smith [20] conclude that there are three main skills that a group needs to complete its goal at hand, namely: problem solving and decision-making skills, interpersonal skills and technical skills. Although other researchers do not prioritise diversity in their findings, no reference is made to contradict these groupings. Blinn [6] and De Vries [12] continue that diversity is valued by teams and is viewed as a competitive advantage. Competitive advantages exist due to varying disciplines, experiences and the transference of skills due to the open communication that exists within high performance teams.

9. Learning

Katzenbach and Smith [20] state that although many teams do not begin with the necessary level of skills, knowledge is learnt through the accomplishment of the goal. Collins [10] further states that formal education may not be a success factor for the development of high performance teams, although training most certainly is. This form of self-learning is further discussed by Verma [32] and De Vries [12] through managing conflict and communication.

10. Fun

Effective teams have fun. Katzenbach and Smith [20] state that high performance teams seem to have a better developed sense of humour and have more fun together than teams displaying lower performance or effectiveness. Francis and Young [13], DeMarco and Lister [11] and Lipman-Blumen [24] further suggest that through an accumulation of a number of factors (including team identity, team success and failures and conflict management), teams begin to both understand and appreciate a group sense of humour.

11. Commitment

High performance teams have a shared attitude of obsession both to goal and each other [6,13,20,22,24,32]. Commitment fuels a team's energies and aspirations [13]. Each member's relationships to the team must be defined in terms of the role to be assumed and the results the role is to produce [22]

12. Appropriate Rewards, Recognition and Appreciation

A characteristic of teams already discussed above is the concept of identity. In light of this, it should be stressed that rewards must be aimed at the team rather than the individual [11,32]. Katzenbach and Smith [20] regard rewards given based on individual performance as contrary to the concept of a team. Furthermore, Blanchard and Carew [5] state that by celebrating team milestones and accomplishments, the greater organisation is made aware of the teams accomplishments and
members feel highly regarded both within the team and as part of the organisation as a whole.

13. Positive Morale and Motivation
According to Straub, Trower and Wetherbe [31], performance is a function of both ability and motivation. High performing team members are typically optimistic about the future and feel confident and committed [5]. They further state that motivation is of key importance to management, as it is a factor which they have some control over. Morale, a component of motivation, results in activities and interpersonal relations being conducted with enthusiasm. Rosen [27] states that morale is a group phenomenon and is not limited to the individual.

14. Quality and performance
High performance teams produce significant results. Commitment to high quality by teams can be viewed as a circular relationship: Team members feel challenged and motivated by high quality. The completion of products leads to feelings of accomplishment and satisfaction that further boost motivation and morale which in turn leads to performance. Satisfaction and therefore productivity are at an optimal level. Proponents of this view include Blanchard and Carew [5], DeMarco and Lister [11], Katzenbach and Smith [20] and Smith [30].

15. Mutual Accountability, Trust and Support
Mutual accountability, trust and support are central themes in research conducted by DeMarco and Lister [11], De Vries [12], Francis and Young [13], Larson and LaFasto [22] and Woodcock [34]. These relationships are seen to exist both between team members and between the team and external management.

16. Flexibility
The responsibility for team development and leadership is shared. Members within effective project groups are often fluid and open to change [5]. Woodcock [34] substantiates this view when he states that in order to arrive at good decisions, a flexible and explicit working procedure must exist that all members understand and adhere to.

17. Team Empowerment
Teams are empowered through successes, access to relevant resources and information and legitimate organisational power (authority and responsibilities). This is both an internal team function and one supported by the organisation at large. High performance teams have significant organisational support and in turn strongly support the organisation [5,9,10,30].

3. Research Approach
The survey instrument used was a questionnaire consisting of thirty-five research questions, seven contextual and background questions and three demographic questions. The response options for the thirty-five research questions were in accordance with a five-point Likert scale.

Respondent’s answers aimed to provide an indication as to the prevalence of each of the 17 team effectiveness characteristics in their team. Thirty-three of the research questions related directly to one, two or three of the seventeen team effectiveness characteristics. Each question not only identified the existence but also measured the level of prevalence, of one or more of the team effectiveness factors in the respondent’s team. The additional 2 questions provided a measure of the perceived level of performance of the team. To ensure all data captured was complete, all thirty-five of the questions had to be completed by the respondent or the questionnaire was void.

The seven contextual questions were aimed at establishing environmental factors that might affect the team. These questions addressed team size, the respondent’s level of IS experience, the current status of the team (active or inactive), if inactive how long the team had been active, the industry and organisation the respondent worked in and their position or role within the team.

3.1 Research Sample
The target sample consisted of seventy-eight individuals from the Information Systems profession. All of the targeted individuals had completed a project management diploma and participated in IS project teams as part of their normal employment.

The organisations they represented varied in size from 20 to 5000 employees and were active in a broad range of industries from Telecommunications through to Finance and Retail. Most of those who reported to be involved in the management of teams displayed significant working experience within the IS field, ranging from 2-20 years; while those who were team members or did not hold positions of authority tended to have
lower amounts of industry experience, typically ranging from 1-6 years.

The questionnaire assessed the effectiveness of a single team in which the respondent has worked. The respondents were requested to report on their most recent team experience. 50% of them were actively involved in a project while the other half answered the questionnaire based on a prior project team that had been disbanded.

The sizes of the project teams ranged from 3 to 50 people with larger teams being more prevalent amongst large organisations. The gender distribution of the sample was split 37% female, 63% male. The final tally of respondents accepted into the statistical sample was 62, the majority of which came from the initial target sample of 78. A sample of this size can be regarded as adequate for an academic study of this nature [8].

The questionnaire was designed as an Internet-based form and placed on the World Wide Web. The responses on the web server were exported into a spreadsheet for analysis. A significant benefit of the use of an Internet-based questionnaire was that all responses were subject to immediate validation, ensuring full regularity and completion of data. Due to this policy, no data was excluded due to errors during the completion of the survey.

Respondents had been sent a covering letter via e-mail explaining the objectives of the study and requesting their participation. All necessary details regarding the completion of the questionnaire were provided, including the Internet address (URL) of the questionnaire. A follow-up letter was sent to those who responded, thanking them for their participation and providing details of when the results of the survey would be released. After 10 days, a follow-up letter was sent to those who had failed to respond, reiterating the objectives of the survey and once again explaining the benefits of participation. A further three days later, those who had still failed to respond were approached telephonically and reminded once again.

4. Research Results

The data was separated into two distinct groups: high performance teams and ‘other’ teams, based on the responses to the questions aimed at assessing the level of the team’s performance both from the respondent’s point of view and that of the organisation.

The data was identified as being especially prone to bias and subjectivity and therefore, before the hypotheses could be tested, it was necessary to identify the possibility of inconsistent data responses. A box and whisker plot was constructed in order to diagrammatically view and eliminate any inconsistent respondents. The division between the ‘high’ and ‘other’ teams can clearly be seen in Figure 2. Outlier values for ‘high’ and ‘other’ teams can be seen as (124; 83) and (115; 58) respectively. No respondents fell outside these values indicating data consistency in the two samples.

The box and whisker graph also emphasises the differences between the two groups, as the upper quartile for ‘other’ teams is lower than the lower quartile of high performing teams. This distinguishes the two samples as 75% of respondents within the ‘high’ sample’s mean score for the questionnaire lie above 75% of those within the ‘other’ teams mean score. In order to visually indicate the difference between the two samples with regards to team characteristics, a simple line graph, shown in Figure 3, was constructed to demonstrate the differences between the mean scores for all characteristics within the two samples.

The line graph plots the weighted average values for high and ‘other’ respondents for each characteristic. The graph shows that high performing teams always show higher levels of the 17 characteristics. Although not proving statistical significance, the graph gives visual representation of the difference between the 2 samples.

4.1 Statistical Analysis

F-tests and t-tests were carried out to compare high-performance teams to ‘other’ teams. The results are displayed in Table 1.

- **F-tests**

  P-values above 0.05 indicated that the variances between the two samples were significantly the same. Values in bold (below 0.05) indicate the converse. Therefore all t-tests were run assuming different variances with the exception of: Clear Goal(s) and Purpose, Identity and Work Approach, Mutual Accountability and Skill Diversity/Heterogeneity.

- **T-tests**

  P-values below 0.05 indicate that the means of the two samples were significantly different. This was the case for all characteristics. The t-tests therefore showed
that there was a significant difference between the means of high performing teams and 'other' teams for every characteristic.

Coupled with this was the fact that the means of high performing teams were higher than the means of 'other' teams for each characteristic as displayed in the line graphs.

Upon closer examination of the results of the t-tests, it was discovered that the following characteristics differed the most when comparing high-performing teams to 'other' teams: Goal ($P = 9.42 \times 10^{-3}$), Conflict Management ($P = 3.13 \times 10^{-3}$), Skill Diversity/Heterogeneity ($P = 1.62 \times 10^{-5}$), Commitment ($P = 6.096 \times 10^{-3}$), Quality and Performance ($P = 1.31 \times 10^{-11}$), and Mutual Accountability, Trust and Support ($P = 1.53 \times 10^{-5}$). This suggests that these factors could be more influential in segregating high performing teams from 'other' teams than the other factors.

Discriminant analysis was conducted in order to identify and rank the various characteristics cited in the literature review. Discriminatory analysis adds further value by distinguishing between characteristics that are significant to those bearing little significance.

The discriminant analysis was performed with a tolerance level of 0.10 and an F-to enter of 1.00 and an F-to remove value of 0.00. The results of this test are, however, inconclusive. The reason for this was attributed to the limitations of the ordinal Likert-scale. For such analysis to be statistically significant, a scaling of approximately 10 data points would be necessary. However, when viewed in conjunction with the following other analyses, various patterns begin to emerge:

Interpreting discriminant analysis results in conjunction with the line graph yields interesting and practical output. Team Empowerment has a relatively small difference between high and 'other' performing teams. This is interpreted as needing a small amount of effort by management in order to increase performance through giving the team more autonomy in making its own decisions. Similarly, Open Communication and Individuality offer management the ability to increase performance through relatively smaller amounts of effort than for example Clear Goal(s) and Purpose.

It was discovered that the results of the discriminant analysis and the results of the t-tests yielded similar outcomes of the most significant characteristics. Table 2 illustrates these results.

All characteristics shown to be significant by the t-tests were also found to be significant by the discriminant analysis. Combining the findings of these two analyses suggest that the most important characteristics that differentiate a high performing team from an 'other' team are: Clear Goal(s) and Purpose, Constructive Conflict Management, Skill Diversity/Heterogeneity, Commitment, Quality and Performance and Mutual Accountability.

5. Conclusions

Klenke [21] notes that many firms are discovering that project teams may be the productivity breakthrough of the modern organisation. Teams, however, often underperform due to a variety of factors encountered both within the team environment and the greater organisation. Specifically, research concerned with the identification of team effectiveness characteristics is both extensive and approaching a collective level of acceptance. This is noted by the continuous cross-referencing of researchers within the literature.

Whilst 17 key characteristics were identified in the research literature as impacting the effectiveness of IS project teams, specific characteristics have been identified as providing statistical significant in differentiating between high-performing teams and 'other' teams. Clear Goal(s) and Purpose, Constructive Conflict Management, Skill Diversity / Heterogeneity, Commitment, Quality and Performance and Mutual Accountability were identified.

The implications for IS project managers are extremely useful. Whilst the project manager should ensure the presence of all the 17 characteristics, the 6 significant ones should receive special focus to increase the team's effectiveness and productivity. Given the general inability of the IS project team to deliver software products on time, on budget and on specification, any increase in team effectiveness is to be encouraged.

References


<table>
<thead>
<tr>
<th>No.</th>
<th>Characteristic</th>
<th>f-test p-value</th>
<th>t-test p-value</th>
<th>Mean (High)</th>
<th>Mean (Other)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Goal</td>
<td>0.0128</td>
<td>0</td>
<td>10</td>
<td>7.63</td>
</tr>
<tr>
<td>2</td>
<td>Communication</td>
<td>0.2509</td>
<td>0.0008</td>
<td>21.09</td>
<td>18.23</td>
</tr>
<tr>
<td>3</td>
<td>Identity</td>
<td>0.0342</td>
<td>0.0001</td>
<td>15.36</td>
<td>12.3</td>
</tr>
<tr>
<td>4</td>
<td>External R/ship Management</td>
<td>0.9147</td>
<td>0.001</td>
<td>11.36</td>
<td>9.4</td>
</tr>
<tr>
<td>5</td>
<td>Conflict</td>
<td>0.2498</td>
<td>0</td>
<td>19.05</td>
<td>15.55</td>
</tr>
<tr>
<td>6</td>
<td>Individuality</td>
<td>0.4769</td>
<td>0.0204</td>
<td>10</td>
<td>8.9</td>
</tr>
<tr>
<td>7</td>
<td>Role</td>
<td>0.2665</td>
<td>0.0003</td>
<td>6.64</td>
<td>5.43</td>
</tr>
<tr>
<td>8</td>
<td>Skill Diversity</td>
<td>0.0091</td>
<td>0</td>
<td>7.18</td>
<td>6.1</td>
</tr>
<tr>
<td>9</td>
<td>Learning</td>
<td>0.608</td>
<td>0.0004</td>
<td>5.91</td>
<td>4.55</td>
</tr>
<tr>
<td>10</td>
<td>Fun</td>
<td>0.3979</td>
<td>0.01</td>
<td>3.09</td>
<td>2.4</td>
</tr>
<tr>
<td>11</td>
<td>Commitment</td>
<td>0.0811</td>
<td>0.0001</td>
<td>13.55</td>
<td>11.18</td>
</tr>
<tr>
<td>12</td>
<td>Rewards</td>
<td>0.6231</td>
<td>0.0006</td>
<td>3.36</td>
<td>2.55</td>
</tr>
<tr>
<td>13</td>
<td>Morale &amp; Motivation</td>
<td>0.9525</td>
<td>0.0002</td>
<td>6.55</td>
<td>5.35</td>
</tr>
<tr>
<td>14</td>
<td>Quality and Performance</td>
<td>0.2903</td>
<td>0</td>
<td>6.36</td>
<td>3.55</td>
</tr>
<tr>
<td>15</td>
<td>Mutual Accountability</td>
<td>0.0003</td>
<td>0</td>
<td>16.5</td>
<td>13.63</td>
</tr>
<tr>
<td>16</td>
<td>Flexibility</td>
<td>0.4043</td>
<td>0.0004</td>
<td>11.95</td>
<td>9.7</td>
</tr>
<tr>
<td>17</td>
<td>Team Empowerment</td>
<td>0.8063</td>
<td>0.0143</td>
<td>5.86</td>
<td>5.05</td>
</tr>
</tbody>
</table>

Table 1 - Results of F and t-tests

Table 2 - Most Significant Characteristics
Figure 2 - Box and Whisker plot of the 2 samples

Figure 3 - Line graph comparing the means of characteristics among the 'high' and 'other' samples