HARDWARE, SOFTWARE AND PEOPLEWARE

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SAICSIT 2001

Edited by
Karen Renaud
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HARDWARE, SOFTWARE AND PEOPLEWARE

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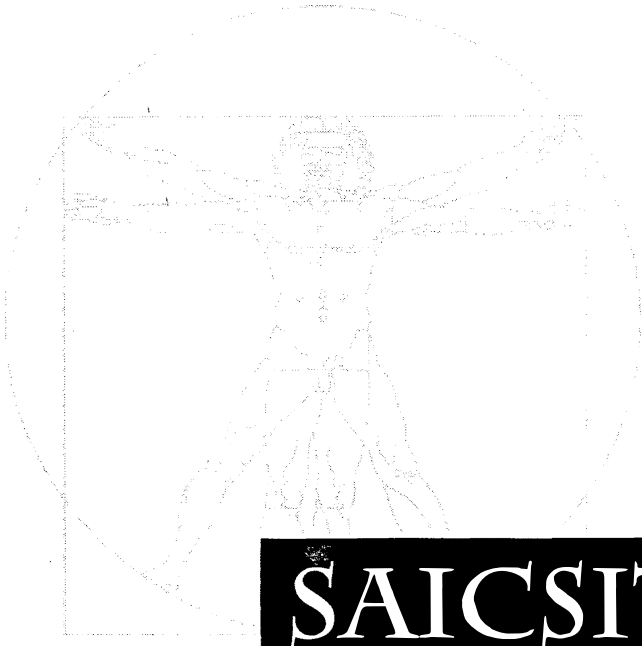

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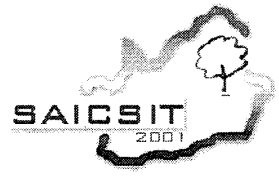

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Message from the SAICSIT President

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.*[1]

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*".

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Keynote Abstracts

The Use of Technology to Support Group Decision-Making in South Africa

JM Nash [a] **D Gwilt** **A Ludwig** **K Shaw**

Dept of Information Systems, University of Cape Town, Rondebosch, 7701
[a] jnash@commerce.uct.ac.za.

Abstract: *This research provides some qualitative insights into the prevalence and use of technologies to support decision-making in South Africa. The paper focuses on two hypotheses: firstly, that decision support technology is not yet being used sufficiently within South African companies to yield significant benefits; and secondly, that such technology as is being used, is limited mainly to "communications enabling" rather than "decision support" tools. Data was obtained from senior business managers regarding their usage of technology to support decision-making, as well as the perceived benefits gained from its use. Further questions were included to collect information about their experiences of meetings and group decision-making. Although the results of the study were not conclusive, the data appeared to support the hypotheses under investigation.*
Keywords: *decision support systems, group decision support systems, management decision-making, technology adoption*
Computing Review Categories: H4.1, H4.2, K6.3

1. Introduction

The globalisation of organisations and the erosion of traditional management structures have resulted in the increasing prevalence of decision-making by groups [3]. Group Decision Support Systems (GDSS) not only support the group decision-making process, but can change the way in which people meet and make decisions [6]. Members of a group can meet at the same time or asynchronously, without being constrained by the number of participants, whether located in the same building or on different continents [16].

The implementation of group decision support technology should prove useful to managers in a country such as South Africa, which has a relatively sophisticated level of information technology, covers large geographical distances and is joining the growing trend towards globalisation.

This study investigates the current use of group decision support technology in South Africa, by examining the extent to which GDSS has been implemented within South African organisations, as well as the use that is being made of decision support technologies by senior managers.

2. Group Decision Making

2.1 Factors Affecting Decision-Making

A decision is "a choice that determines what action, if any, shall be taken, or what policy shall be adopted to deal with a problem situation" [11]. Decision-making is generally considered to be a sequential process, in which the problem is identified, alternatives are developed and evaluated, and one of the alternatives is then selected and implemented [12]. However, individual decision-making may be limited in a number of ways, particularly when unstructured decisions are involved. The human mind is constrained in terms of attention, memory and calculation [13], and individuals are often overconfident about their own judgement [1].

The use of groups for decision-making can help to overcome some of these limitations, because groups possess more information and knowledge, and can process information more efficiently, while member participation increases acceptance of the decision and commitment to its implementation [19]. Nevertheless, a number of problems may arise within the group decision-making process, such as domination by individuals, pressure to conform, insufficient attention being paid to the exploration of the problem, the effect of interpersonal relationships, miscommunication and low productivity [13, 14, 18, 20].

2.2 Technological Support For Group Decision-Making

Group Decision Support Systems have been defined as interactive computer-based systems which combine communication, computer and decision technologies to support the formulation and solution of unstructured problems by a group [15]. GDSS has been shown to improve participation as a result of parallel information input, group memory and anonymity [4, 15]. Support is also provided for brainstorming, categorizing and prioritization,

voting, policy formulation, evaluation of alternatives and strategic planning, which contribute towards improved process effectiveness [2]. The structure of a GDSS meeting helps to focus the group on the problem [7], creativity and synergy are increased [9], and in same-place environments, decisions tend to be made in less time, with higher levels of satisfaction.

Information technology can be used to provide support for three separate aspects of group decision-making: by facilitating communication between group members, by improving the quality of the decision-making process, and in selecting the alternative to be implemented [6].
Level 1: Communications assistance
Level 2: Decision-making assistance
Level 3: Making the decision

At the communications level, technologies such as electronic bulletin boards, teleconferencing, email and group editing can remove barriers of time and space, increase the number of participants in decision-making, and provide an electronic memory [16]. The quality of the decision-making process may further be improved through the inclusion of strategies such as the Delphi and Nominal Group techniques, while judgement with respect to the final decision can be improved through the application of rules to filter and structure information [21].

2.3 Adoption of Group Decision Support Technology

The effect of attitude on the adoption of information technology by managers has been researched by Licker [17], who describes a five-level model of attitude change, originally developed at Yale University (Figure 1):

Attention and awareness as a result of advertising, publication or word of mouth.
Comprehension and knowledge about the technology and its uses.
Yielding, where the potential adopter tries out the technological innovation.
Use of the technology.
Reinvention, where systems are improved or their use is varied to receive maximum benefits from the existing technology.

3. Research Methodology

3.1 Objectives

While there are well-documented examples of the use of group decision support technologies in the United States, and to a lesser extent in Europe and Australia/New Zealand, there is little evidence to suggest that these technologies are being used effectively in Southern Africa [10]. A recent study by de Vreede [22] suggests that GDSS use in Southern Africa is affected by cultural factors, such as the influence of personal relationships on decision-making.

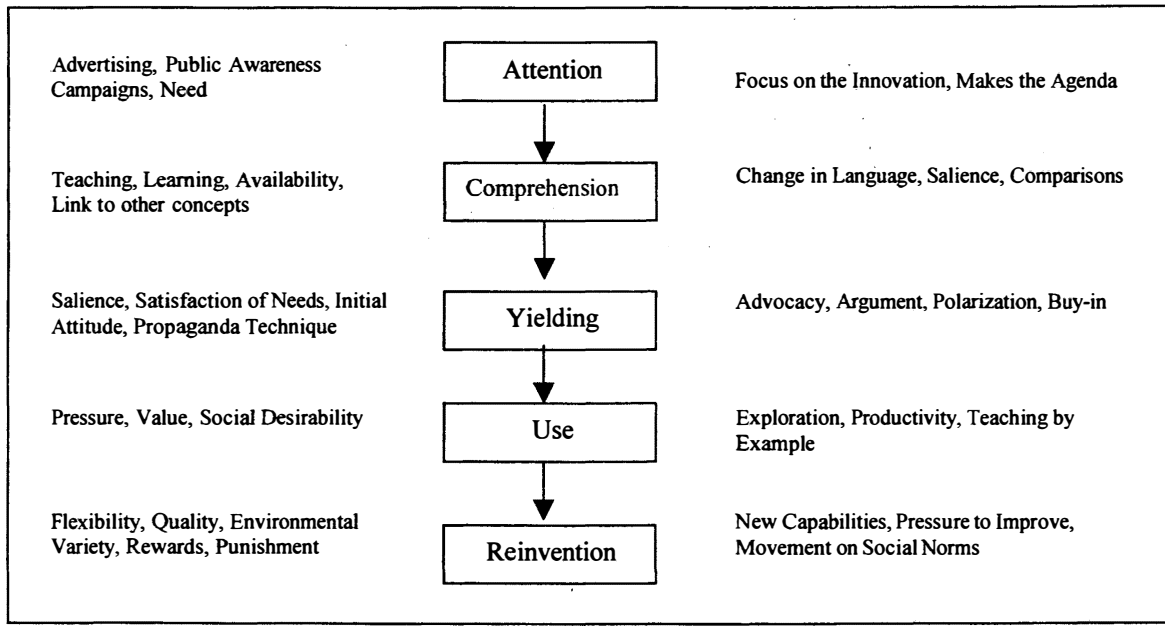

Figure 1. *Yale Model of Attitude Change*

This study investigates the extent to which GDSS is being used in South African companies, and which aspects of the decision-making process are most effectively being facilitated through its use. Two hypotheses are examined:

Hypothesis 1: GDSS technology has not yet been adopted within South African companies to the extent where it is likely to provide effective support for decision-making.
This hypothesis is tested in terms of the Yale University model of attitude change [17].

Hypothesis 2: GDSS is used more prevalently to aid communication than to support the decision-making process.
This hypothesis is tested in terms of the three levels at which technology can support decision-making, proposed by DeSanctis [6].

3.2 Data Collection

The data used in this survey was obtained from a random sample of large listed companies in South Africa. Thirty-nine companies were selected from the JSE Handbook, covering 13 different industries. For each organisation in the research sample, a senior executive involved in group decision-making was contacted telephonically to request participation and a guarantee of the anonymity of the company was provided.

The survey instrument was sent to each participant using either email, facsimile or express mail, with repeated follow-up calls to ensure a good rate of return. Completed questionnaires were returned by fax or email. Out of the research sample of 39 companies, 13 completed questionnaires were received, a 33% response rate. This small sample size may have detracted from the usefulness of the results, since quantitative methods of data analysis could not be used.

The questionnaire used for this survey was sent to business managers only, since it was felt that they would be in the best position to provide information about the usage of technologies in the decision-making process. However, they were not always able to provide accurate information as to which technologies had in fact been acquired by the organisation, or the motivation for their acquisition. The small number of responses obtained (13) was also a limiting factor in interpreting the results of this study.

3.3 The Research Instrument

A four-page questionnaire was designed by the researchers based on existing literature in the field of GDSS, specifically to elicit information about problems currently being experienced during the group decision-making process, and about the actual use of GDSS technologies within the organization [3, 13, 14, 18].

Questions focused on two areas:

(a) The group decision-making process
Respondents were asked to identify the predominant style of group decision-making meetings, typical problems experienced during group decision-making, the method by which group decisions were reached in meetings, and the benefits that they would most value from group decision support technologies.

(b) Use of GDSS technology
Respondents were asked to identify the GDSS technologies owned by their organisations, and to specify how frequently they were used. Where GDSS technologies were being used, respondents were asked what benefits were being attained. Reasons were requested for the situations where GDSS technologies were owned but not used, or where GDSS technologies had not been acquired by the organisation.

GDSS technologies included in the survey were :

- Electronic bulletin boards
- Audio / teleconferencing
- Video conferencing
- Screen/desktop sharing
- Email
- Group editing
- Electronic voting tools
- Electronic brainstorming
- Proprietary GDSS
  (The term "proprietary GDSS" is used to distinguish multi-function GDSS products such as GroupSystems from the individual technologies listed above.)

All questions allowed respondents the opportunity to provide additional information about their experience of the decision-making process and use of technology.

4. Data analysis

Each completed questionnaire was summarised on to a single page, and the response frequencies totalled and tabulated.

Initial inspection of the data revealed that companies were almost equally divided between formal and informal meeting styles (54% formal, 46% informal). Losing sight of goals during meetings was seen as the most common problem (69% of respondents), regardless of meeting style; followed by dominant personalities (62%) and lack of productivity (46%). Consensus rather than voting was the most common basis for decision making in all 13 companies.

There was no clear support for any particular potential benefit to be gained through the use of technology. The most popular responses were cost saving through time saving (46%), greater participation (46%), higher quality decisions (38%), geographically dispersed meetings (38%) and better quality of ideas (38%).

A number of technologies that support groupwork appear to be widely used within South African organizations. Of those surveyed, 100% were using email, 92% using teleconferencing, 62% using videoconferencing and group editing systems, and 46% using electronic bulletin boards. However, only 15% of the respondents were making use of proprietary GDSS technology.

The survey data was then qualitatively analysed in terms of the Yale University attitude adoption model [17], and the three-level group decision-technology model [6].

5. Results

5.1 Hypothesis 1

GDSS technology has not yet been adopted within South African companies to the extent where it is likely to provide effective support for decision-making.

The Yale University model of attitude change proposes five stages of technology acceptance: attention and awareness, comprehension and knowledge, yielding, use and re-invention. An additional preceding stage, unawareness, was added for the purposes of this study, and the final category of re-invention was omitted. In order to assess the adoption of technologies to support decision making in South African organisations, each technology was assessed in terms of its actual use within each organisation, and classified into one of five stages (Figure 2).

Blank responses were omitted from the data analysis, although in some cases this might have reflected a condition of unawareness of the technology.

For the majority of GDSS technologies, most organizations had reached the level of either **awareness** or **knowledge**, although a proprietary GDSS was being used (infrequently) in only one organization.

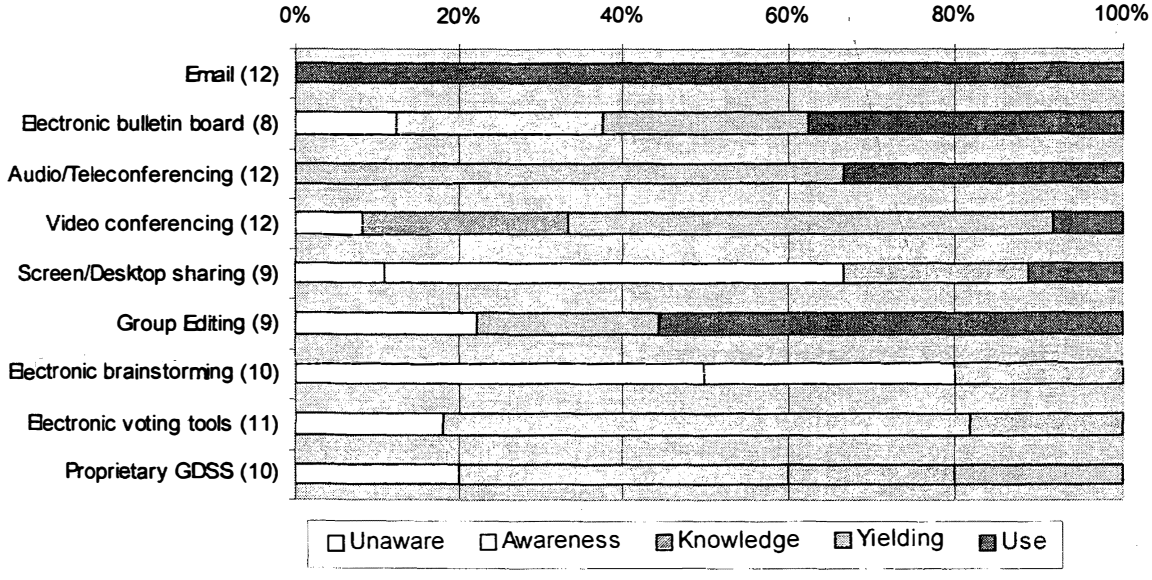

Figure 2 *Level of Awareness for each technology*

The **yielding** stage represents the situation where an investment has already been made in technology, but only limited use is being made of it. Although the full cost has been incurred, only limited benefits are likely to be achieved.

Examination of the above graph in terms of those technologies which are **in use**, suggests that technologies which support an existing decision making process have been more readily adopted than those which seek to improve on the process itself. In general, these can be considered to be "communication" technologies, as opposed to "decision-making" technologies; this aspect is investigated further under the second hypothesis.

Overall, these results would suggest that while the **efficiency** of the decision-making process has been improved through the use of facilities such as email, teleconferencing and bulletin boards, the actual process still adheres to a traditional meeting format and does not take advantage of the process improvements offered by other GDSS technologies. This limited adoption of decision support technology tends to support H1.

5.2 Hypothesis 2

GDSS is used more prevalently to aid communication than to support the decision-making process.

The second hypothesis was examined based on the three levels of decision-making support proposed in [6]. The underlying premise is that managers have adopted technologies that allow them to overcome communication barriers, while overlooking technologies that would influence the actual decision-making process. Because of the low number of participants in the study, the levels of "decision-making assistance" and "making the decision" were combined, to give two possible categories: communications support and decision support. Each of the technologies being investigated was assigned to one of these categories, based on its primary function [20].The fact that organisations owned 45 technologies in the "communications" group, and only 1 technology in the "decision support" group (Table 1), appears to provide strong positive support for H2. Since there are twice as many communications support tools listed than decision support tools, a mean value has been calculated to show the average number of organisations owning these tools; while this figure has no statistical validity, it serves to illustrate the considerable difference in ownership patterns.

6. Discussion

6.1 Extent of adoption of GDSS technology

All of the companies that were responded to this part of the questionnaire, were using email to support group decision making, and more than half of the companies also made use of conferencing and group editing tools. The other technologies under investigation were used by a minority of companies or, as in the case of electronic brainstorming and voting tools, were not being used at all.

It is disturbing to note the low levels of awareness or knowledge of many technologies. While proprietary GDSS technology is intended specifically to support management decision-makers, less than half of the managers who were interviewed were even aware of the benefits offered by this technology. Overall, for four of the nine technologies, managers in less than 40% of the companies had specific knowledge of the benefits they could offer.

Communications Support		**Decision Support**	
Email	(12)	Electronic brainstorming	(0)
Electronic Bulletin Board	(5)	Electronic voting tools	(0)
Audio/Teleconferencing	(12)	Proprietary GDSS	(2)
Video Conferencing	(8)		
Screen/Desktop sharing	(1)		
Group editing	(7)		
Total: 45	Mean: 7.5	Total: 2	Mean: 0.67

Table 1 – *Prevalence of Communications and Decision Support Tools*

This would suggest inadequate levels of marketing of these products.

Also of concern is the observation that many companies were placed in the "Yielding" category, implying that an investment had been made in technology, but with only limited or intermittent use. Costs would have thus have been incurred, but without the corresponding achievement of significant benefits. In fact, all three of the companies that cited "Justifying return on investment" as a significant problem, had technologies within the "Yielding" category; while companies with technologies at the "Use" stage reflected a markedly increased number of benefits from their adoption of technology.

Because of the qualitative nature of the data, it is not possible to pronounce H1 clearly true or false. However, the majority of the technologies that were investigated, showed very limited adoption levels, especially with regard to specific group decision support technologies. This appears to support the hypothesis that GDSS technology has not yet been adopted in South Africa to the extent where it can provide effective support for decision-making.

6.2 Use of technology in the decision-making process

The organisations that were sampled showed a far higher level of ownership of tools to support communication, than of tools to support the decison-making process itself.

Because people resist changes in the way that they work, it is possible that technologies which simply automate an existing process will encounter less resistance than those which necessitate a change in the process itself. In the process of decision-making, technologies can be categorised as communication enablers or decision supporters. By limiting the adoption of technology to those that help overcome communication barriers, managers are not experiencing possible benefits that could arise from changes in the decision-making process itself, such as improved structure, focus and clarity of ideas.

All of the managers who were interviewed stated that "consensus" was the dominant method of arriving at a final decision. This would necessitate high levels of interactive communication, and might explain the low usage of electronic voting tools. In addition, technologies aimed at supporting communications can be applied to a broader range of contexts than decision-making alone, and probably demonstrate a greater return on investment.

Problems of computer literacy experienced by 54% of respondents could also mitigate against the deployment of complex decision-support technologies. The African field studies conducted by de Vreede [22] found that computer literacy, oral communication preference and referent power issues were factors affecting the successful use of GDSS. Other research [20] has indicated that in competitive environments, cooperation and sharing are not seen as success factors, and groupware products are likely to find limited use.

7. Conclusion

Since this survey found 45 instances of technologies being used to support the communications aspect of decision-making, and only 2 instances of technologies being used to support the decision-making process itself, it would appear that that the use of group decision support technologies which aid communication is indeed more prevalent than the use of technologies which enhance the decision-making process.

The levels of adoption of decision support tools within organisations varied considerably across the different technologies that were investigated. The underlying motivation for this pattern of technology adoption is not clear, and could perhaps be related to the perceived range of benefits offered by a technology. Managers in general had low levels of knowledge about the more sophisticated decision support tools available to them.

Nevertheless, it does appear to be true that South African companies have adopted those technologies that serve to remove potential barriers to communication, as opposed to those that provide improved support of the decision-making process. In doing so, they have received various benefits relating to improved efficiency of communication and increased participation in decision-making; however, they continue to experience problems such as losing sight of goals and poor productivity, which decision support technologies claim to alleviate. This situation may well persist until such time as managers are persuaded that the cost of such technologies, in terms of money, time and training, is likely to be outweighed by their potential benefits.

The small sample size used in this study has severely limited the generalisability of the results. Further research needs to be done in this area to establish whether clear patterns can be identified in the ownership and use of GDSS technologies, and to understand the underlying factors such as levels of computer literacy and the influence of corporate culture, that may affect GDSS usage in South Africa.

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