Managing oral health in the Oral Health Service of the South African Medical Service: A Systems Approach

by

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Submitted to partially fulfil the requirement
of the
MChD degree (Community Dentistry)
in the Faculty of Dentistry
University of Pretoria
Pretoria

October 1993

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
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Declaration

I, Johannes Hendrik Viljoen, declare that *Managing oral health in the Oral Health Service of the South African Medical Service: A Systems Approach,* which I herewith submit to the University of Pretoria for the MChD degree (Community Dentistry) has not previously been submitted by me to any other university.

Johannes Hendrik Viljoen

27/01/94
Date

"The things that have been, it is that which shall be;
and that which is done is that which shall be done:
and there is no new thing under the sun."

Ecclesiastes 1:9

"The fear of the Lord is the beginning of knowledge:
but fools despise wisdom and instruction."

Proverbs 1:7

Dissertation Outline

Proposed Reading Schedule

It is proposed that the dissertation is read as indicated in the figure below.

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Executive Summary

Managing oral health in the Oral Health Service of the South African Medical Service: A Systems Approach

by

Johannes Hendrik Viljoen

Leader :	**Prof LM Rossouw,** Department Community Dentistry, Faculty of Dentistry, University of Pretoria
Co-leader :	**Prof WD Snyman,** Department Community Dentistry, Faculty of Dentistry, University of Pretoria
External Examiners :	**Prof G Erens** **Dr J Hartshorne**
Department :	**Community Dentistry**
Degree :	**MChD (Community Dentistry)**

Problems concerning the planning and practicing of health care currently exist. Countries are spending more funds on medical care without making a discernible dent in the health status of their citizens. This lack of success in obtaining health is obviously a problem for everyone experiencing ill health or the effects thereof. It also creates a personal problem for all health workers, because a halt is being called to profligate spending on health that will affect all. The problems underlying the health care crisis are rising costs, unequal distribution, low productivity, poor health status, and a lack in sensitivity towards the communities it serves. The multi-disciplinary, complex nature of these problems in health care, their magnitude and their inter-relatedness indicate that traditional approaches to health care planning and management have been inadequate or have failed. An alternative approach to solve these problems is to adopt a holistic view, i.e., to see all parts (components) which contribute to the problem as parts of the whole. By viewing the problem as a whole, more enduring solutions may be formulated.

The aim of this study was to employ and evaluate the adoption of a systems approach to solve "real life" problems. The Soft Systems Methodology of Peter Checkland was

utilized to assess the situation within the Oral Health Service of the SAMS and to identify relevant systems to improve the situation. The need for a Preventive System and a Performance Measurement System was established. These two systems were planned, developed and implemented using and obeying systems rules and techniques. Both these systems were evaluated and found to be highly efficient, effective, cost-effective and made a positive net contribution to the Oral Health Service of the SAMS.

It is finally concluded that the adoption of a systems approach to identify and solve "real life" problems was effective and efficient. It is therefore recommended that a systems approach to the management of oral health, and probably health too, should be embraced by the encumbered health industry.

Opsomming

Die bestuur van mondgesondheid in die Mondgesondheidsdiens van die Suid Afrikaanse Geneeskundige Diens: 'n Stelsel Benadering

deur

Johannes Hendrik Viljoen

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Daar is tans probleme in die beplanning en lewering van gesondheidsdienste. Meer fondse word in gesondheidsorg geïnvesteer sonder dat die gesondheidstatus van populasies verbeter. Hierdie gebrek om gesondheid te verbeter is 'n probleem vir diegene wat aan siekte ly, maar ook vir die verskaffers van gesondheid omdat die verkwisting van fondse gestaak sal moet word. Die probleme in die gesondheidsindustrie is die stygende kostes, die wanverspreiding, lae produktiwiteit, swak gesondheidstatus en 'n gebrek aan gemeenskapsgerigte dienste. Die multi-dissiplinêre, komplekse aard van genoemde probleme, asook die omvang en verwantskap tussen die probleme dui daarop dat die tradisionele benadering tot die bestuur van gesondheidsorg gefaal het. 'n Alternatiewe benadering is om 'n stelselbenadering te aanvaar, waar gepoog word om die invloed van die dele op die geheel te erken. Deur die probleem as sulks te beskou kan moontlik aanleiding gee tot die formulering van blywende oplossings.

Die doel van die studie was om 'n stelselbenadering te gebruik en te evalueer in die oplossing van "werklike" probleme. Die "Soft Systems Methodology" van Peter

Checkland is gebruik om die situasie in die Mondgesondheidsdiens van die SAGD te ontleed en nodige stelsels te identifiseer om verbetering aan die hand te werk. 'n Voorkomende- en 'n prestasiemetingstelsel is beplan, ontwikkel en geïmplementeer deur die gebruik van stelseltegnieke. Beide die stelsels is geëvalueer en daar is bevind dat dit doelmatig, doeltreffend en koste-doeltreffend was, en dat dit 'n positiewe netto bydrae tot die Mondgesondheidsdiens van die SAGD gemaak het.

Die gevolgtrekking is gemaak dat die gebruik van 'n stelselbenadering doeltreffend en doelmatig is in die identifisering en oplossing van "werklike" probleme. Dit word dus aanbeveel dat die wankelende gesondheidsindustrie 'n stelselbenadering tot die bestuur van mondgesondheid en selfs gesondheid moet aanvaar.

Acknowledgements

All praise and glory to my Lord Jesus Christ the one true God from whom all things have come.

I wish to express my sincere appreciation to the following people:

My leader, Prof LM Rossouw for his encouragement, understanding, guidance and constructive criticism throughout this investigation.

My co-leader, Prof WD Snyman, for his interest and support.

My Director, Brig JT Barnard, for his leadership and commitment to improvement.

My wife, Margaret, for her love, understanding, support and dedication to our family.

My daughter, Anika, for her unconditional love and energy, and understanding that daddy is always working.

My parents, who gave the me the opportunity to be myself.

My colleagues,. Dr Wessel Holtshousen, Dr Derik van Rensburg and Dr Jeroen Kroon for their friendship and support.

Cmdt Chris De Jager, Staff Officers Oral Health Northern Medical Command, for the opportunity to work with him, as well as his friendship, support and contribution.

Miss S Booyens and miss E Oosthuizen for their support in the Preventive Project.

Oral hygiene students for their hard work and dedication since 1990.

All the members of the Department Community Dentistry, University of Pretoria.

All the members of the Directorate Oral Health, SAMS.

Everybody that participated in the study.

My friends and family, for their love and understanding during the past 4 years.

List of abbreviations

ACMR :	Advisory Committee on Medical Research
ADep :	Adult dependants
CATWOE:	Customers, Actors, Transformation, Weltanschauung, Owners, Environmental constraints
CDep :	Children dependants
DMFS :	Decayed, Missing and Filled Surfaces (Permanent teeth)
dmfs :	Decayed, missing and filled surfaces (Primary teeth)
DMFT :	Decayed, Missing and Filled Teeth (Permanent teeth)
dmft:	Decayed, missing and filled teeth (Primary teeth)
DT :	Decayed Teeth
FT :	Filled Teeth
GDP :	Gross Domestic Product
HQ :	Headquarters
MRC :	Medical Research Council
MT :	Missing Teeth
OC :	Officer Commanding
PF :	Permanent Force
POHC :	Primary Oral Health Care
SADF :	South African Defence Force

SAMS :	South African Medical Service
SM :	Service men
SSM :	Soft Systems Methodology
TED :	Transvaal Educational Department
UP :	University of Pretoria
WHO :	World Health Organization

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CHAPTER 1

INTRODUCTION, PROBLEM, OBJECTIVES AND FRAMEWORK

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CHAPTER 1

INTRODUCTION, PROBLEM, OBJECTIVES AND FRAMEWORK

*The manager's job is change. It is what we live with.
It is what we are to create. If we cannot do that,
then we are not good at the job. It is our basic job
to have the nerve to keep changing and changing
and changing again.*

Sir Peter Paker (1986, p 11)

1. Introduction - The need for a different approach

The British Empire was troubled by the problem of war and securing her power between the years 1810 and 1820. The Duke of Wellington played a major role in decision making and strategy implementation. Although he at first did not like artillery ("because it frightened the horses" (Johnson, 1991, p 12)), he was forced to change to survive.

Change has become inevitable, and mostly because of the explosion in knowledge witnessed by man the last 10 to 20 years. The prophet Daniel foresaw this multiplication of wisdom about 2500 years ago (Dan. 12:4). Due to analytical and scientific thinking this knowledge is however mostly fragmented and fragmenting (Cavalieri, 1986, p 23). According to some authors this fragmentation of knowledge contributes to the complexity of today's problems (Cavalieri, 1986, p 24 and Duncan, 1978, p 16). The same authors contend that problems actually become more complicated by our continued application of scientific analysis.

Certain problems can be resolved with conventional problem-solving procedures. Such problems are mechanistic, and would be more typical of those in a relatively closed system, insulated from interferences of other problems (Cunningham and Farquharson, 1989, p 126). Scientific research is typically performed in a closed system. This is probably why scientific research can answer many questions, but when these answers are tested in real life they tend to fail.

In real life most problems are more systemic in nature, because they are interrelated to other problems and to other aspects of a larger system (e.g. society). Systemic problems are related to and arise out of the complexity of the situation and require a management approach that is systemic in nature, not mechanistic. This new approach that tends to see the whole rather than the parts is therefore called a wholistic or systems approach. Such a new approach to management means change. We will have to change the way we are thinking, making decisions and planning strategies.

The health industry is in no way exempted from the analogy drawn above. Problems concerning the planning and practicing of health care currently exist. Countries are spending more funds on medical care without making a discernible dent in the health status of their citizens. This lack of success in obtaining health is obviously a problem for everyone experiencing ill health or the effects thereof. It also creates a personal problem for all health workers, because a halt is being called to profligate spending on health that will affect all. The problems underlying the health care crisis are rising costs, unequal distribution, low productivity, poor health status, and a lack in sensitivity towards the communities it serves.

The multi-disciplinary, complex nature of these problems in health care, their magnitude and their inter-relatedness indicate that traditional approaches to health care planning and management have been inadequate or have failed. An alternative approach to solve these problems is to adopt a holistic view, i.e., to see all parts (components) which contribute to the problem as parts of the whole. By viewing the problem as a whole, more enduring solutions may be formulated.

Although changes usually "frighten the horses" this candidate proposes that the health industry and the dental industry in particular, will have to change to survive. With this background the rest of this chapter deliberates: [1] Briefly, the problem within the Oral Health Service of the SAMS; [2] The rationale, significance and need for the study; [3] The aim, objectives and premise of the study; [4] The delimitations and limitations of the study; [5] The reference technique; and finally [6] The approach to and framework of the dissertation.

2. The Problem

A brief background to the problem is outlined (a detailed situation analysis follows in Chapter 2), whereafter the research problem is stated.

2.1. Background to the problem

The Oral Health Service of the South African Medical Service (SAMS) is an oral health system simplified by a triangular relationship between the oral health team, the delivery system and the patient or community (Fig.1.1). The Oral Health Service is responsible for rendering oral health services to the population of the South African Defence Force.

Until 1989 the rendering of services was demand-based, and primarily driven by demand factors such as: the existence of dental disease; the dental awareness of the population; and the attitude of the dental care team to dental disease and its treatment (Fig. 1.1). The dental team predominantly existed of newly qualified dentists doing their 2 year compulsory military service. The most expensive resource in health services was thus available in excess at almost no cost. Since 1990 however, the number of dentists reporting for military service has declined to zero. The population of the Oral Health Service of the SAMS (clientele) did however not decline, and therefore less dental personnel costing more money had to be utilized to meet the same demand. The two options available to the Oral Health Service were to stop the curative demand and secondly to increase productivity (performance) of dental personnel at the operational level.

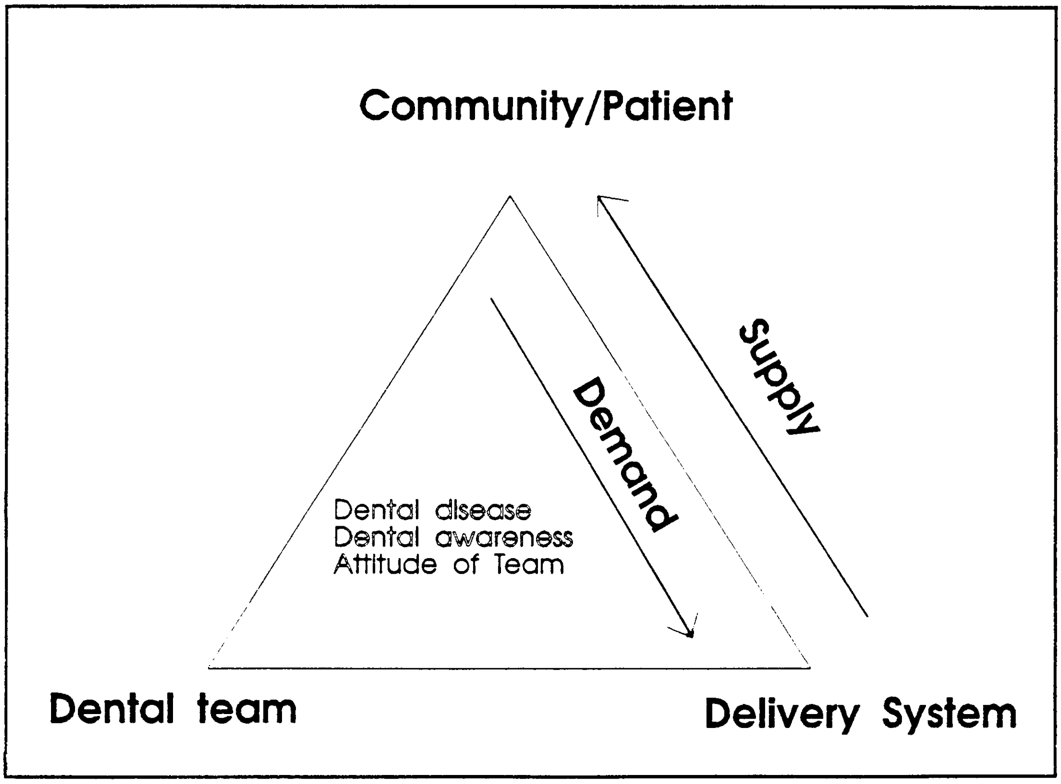

Figure 1.1: The Oral Health System of the South African Medical Service.

A presentation to the Surgeon General in 1989 lead to the acceptance of a preventive oriented oral health service. Since then, the Oral Health Service formulated its mission statement as: *"To conquer oral disease in co-operation with our patients"* (Directorate Oral Health, 1991, p 14). Although the Directorate Oral Health is committed to the prevention of oral disease and the improvement in operational performance the providers of services on the operational level have remained largely curatively oriented and productivity has not increased. The challenge was to implement the Directorate's (top management's) commitment to prevention and productivity at the operational or provider level.

2.2. Detailed statement of problem

In summary the problem this study intends to address is the lack of preventive care and the performance problem at the operational level in the Oral Health Services of the South African Medical Services.

3. Rationale, significance and need for the study

3.1. Rationale

The study is firstly based on the rationale that adopting a systems approach to the management of oral health services is the desired way to solve real life problems, secondly that prevention is better than cure, and thirdly that performance in oral health services can be measured and can be improved. In a systems approach the second and third statements imply that the output of the health care delivery system is **health** rather than just the cure of disease.

Due to the influence of the demand factors mentioned under "Background to the Problem" the Service has remained curatively oriented on the operational level. Calculations based on the analysis of epidemiological surveys and service statistics of the oral health service show that a **reactive (curative) dental treatment approach** ("traditional approach") will not eliminate dental disease in the population of the South African Defence Force. The 1987/88 epidemiological data stated a curative backlog of R 40,5 million (Rossouw *et al*, 1987, p 148). In addition, service statistics have not shown a substantial increase in the volume of preventive treatment, or any decline in the volume of curative and restorative care. The problem in the SAMS is further complicated by a diminishing trend in the availability of health care resources. This curative or re-active approach is typical of a system that defines it's output as the treatment of disease. Therefore an innovative approach to oral health care delivery with optimal use of available resources, was required. This innovative approach implied that the Oral Health Service of the SAMS should be seen as a system with **oral health** as an output and not merely the cure of disease.

A systems approach where the output of the system is defined as oral health is in direct contrast with the curative approach where the output of the system is defined as the treatment of disease. If the output of the system is defined as oral health the system does not only cope with the demand, but it strives to eliminate the causative factors that creates the demand. Within this pre-active systems approach are probably at least two types of system strategies. Firstly **project strategies** are community oriented preventive programmes such as oral health education, tooth brushing and fissure sealant programmes, managed as independent sub-systems.

The second type is a **total system strategy**, where all the inputs of the system are managed to perform in accordance with the objectives of the oral health system. The different approaches to dental care are summarized in Figure 1.2.

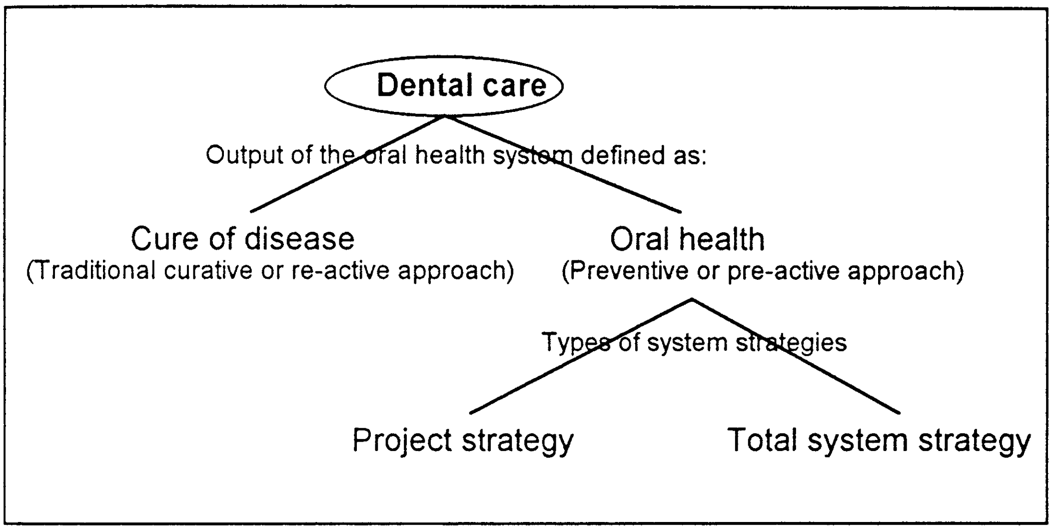

Figure 1.2 : A summary of the different approaches to oral health care.

3.2. Significance and need for the study

Firstly an analysis of the nature of the research problem suggests that the problem consists of: [1] The need to implement and assess a preventive programme or project in a real life setting, and [2] The need to improve performance in terms of oral health. The nature of these two problems under discussion suggests that they should be viewed as health systems research problems, i.e. research on the resources, organizations, and accomplishments of health care (WHO, 1984, p vii). Health systems research was assigned a top priority by the Global Advisory Committee on Medical Research (ACMR), WHO, and its six regional Advisory Committees on Medical Research. The aim of health systems research is to be so closely linked to field realities that the results can directly and rapidly be applied (WHO, 1984, p vii).

Secondly the health and cost advantages of prevention versus cure are generally accepted and well established within the dental scientific community as well as the dental literature. However dental practitioners within private, public and semi-public services have often shown a reluctance to embrace radical preventive strategies. According to the Lege Artis Principles it is the profession's duty to continuously practice the profession while following the frontier level of science and experience. Improvements in approaches that prevent oral disease through the most optimal utilization of the oral health care system's resources should always be pursued.

Thirdly this study describes the first preventive dental programme (project) in the SAMS. The 1987/88 epidemiological data showed that prevention of occlusal dental caries in children (age 6 to 8 years and 11 to 13 years) should be the highest service priority. The need for such a programme is to prevent the incidence and prevalence of occlusal caries in 6 to 13 year old children. The data of the 1987/88 survey indicated that the premolars accounted for less than 5% of the dental caries. To ensure the efficient use of resources premolars should therefore not be sealed. The first molars, however, contributed 50-60% and the second molars 18-25% (total of 68-85%) to the total DMFT of 3,6 (± 3,06 teeth per mouth). About 85% of these caries is located in the pits and fissures of the teeth and can thus be prevented by pit and fissure sealants. Calculations show that a sealant programme can potentially save 2,6 fillings per mouth which confirms that this programme should be a priority.

Fourthly the study addresses the lack of performance (productivity) defined in terms of oral health in the dental clinics by means of a total system strategy. Given the limited resources available and the lack of performance a drastic approach to turn the main thrust of the Oral Health System from merely the cure of disease on demand to a dynamic system taking charge of it's destiny and the oral health of it's clientele, is needed.

Therefore, this study may contribute to the acceptance of a realistic methodology to oral health management, the formulation of more efficient preventive dental care strategies for the Oral Health Service of the SAMS, and the improvement of operational performance.

"I find it as difficult to know the parts without knowing the whole, as to know the whole without specifically knowing the parts."
Blaise Pascal

4. Study objectives

4.1. Aim

The aim of the study is to employ and evaluate the adoption of a health systems approach to solve the lack of preventive care and to improve oral health performance at the operational level in the Oral Health Service of the SAMS.

4.2. Objectives

The objectives of the study are to:

- ➪ Use and evaluate a systems approach to oral health management in the SAMS
- ➪ Plan, implement and evaluate a preventive project for children of SADF members in primary schools in Pretoria.
- ➪ Plan, implement and evaluate a system to measure and improve performance in the Oral Health Service of the SAMS.

4.3. Premise

The premise of this study is that adopting a systems approach to the management of oral health is the solution to the implementation of preventive care and the improvement of performance at the operational level of the Oral Health Service of the South African Medical Service.

5. Delimitations and limitations of study

5.1. Delimitations

The delimitations of the study are discussed as applicable to the system, the study population, and the research and design method.

5.1.1. System

The system is limited to: [1] The Oral Health Service of the SAMS with it's containing systems; [2] The SAMS as a contained system; and [3] The clientele.

5.1.2. Study population

5.1.2.1. Project strategy

The study population for the preventive project was delimited to the primary school children of SADF members living in Pretoria. The population is described in detail in Chapter 4 paragraph 2.3.1.1.

5.1.2.2. *Total system strategy*

The study population for the measurement and improvement performance of service providers includes all the dentists working in oral health clinics of the SAMS.

5.1.3. Research design and method

The methodology of this research project is both phenomenological and logical-positivistic. The use and evaluation of the system methodology and approach are mainly phenomenological and more qualitative, while the study on the preventive project and the performance measurement system is logical-positivistic and more quantitative.

The study can primarily be classified as oral health systems research and can be sub-classified as action (operational) or evaluation research. The research is thus conducted to solve a specified "real life" problem.

5.2. Limitations

The limitations of the study are deliberated under the headings: use of the systems approach, preventive project, and performance measurement.

5.2.1. Use of the systems approach

Concerning the use of the systems methodology and approach the following limitations of the study are acknowledged:

- ⇨ The use of the systems approach to the management of oral health in the SAMS is limited to the knowledge of the candidate, the project leader and available literature.
- ⇨ The success of the systems approach is evaluated qualitatively. Qualitative research per se is an uncommon phenomenon in the empirical sciences such as dental science.

5.2.2. Preventive project

The limitations of the preventive project are as follows:

- ⇨ The influence on caries incidence due to outside factors, such as the home use of fluoridated toothpaste, personal oral hygiene procedures, diet and fluoridated drinking water was recognized but not included in the evaluation.
- ⇨ The loss of patients during the study period due to transferrals of permanent force members.

- The absence of children from school due to illness or other reasons.

5.2.3. Performance measurement

The study on the measurement and improvement of performance acknowledged the following limitations:

- The influence of increased demand and improved clinical skills of young dentists on the performance of dentists were recognized but not included in the evaluation.
- The manpower turnover in the period of evaluation.

6. Reference technique

The Harvard Technique of reference, described in *Riglyne vir die Voorbereiding van Werkstukke* (UP Biblioteekdiens, 1989, p 6-11) is used in this dissertation.

7. Approach and framework

This dissertation follows Peter Checkland's soft systems approach to problem solving - known as the Soft System Methodology (SSM) (Fig. 1.3). Systems, systems thinking and systems approaches are discussed in detail in Appendix A. In short the use of a systems approach is justified by the following:

- The manager of oral health services can be so occupied by the demand of the population, the distribution of resources and daily problem solving that he loses sight of the real output of an oral health system, namely oral health and not merely the cure of existing disease.
- The systems approach acknowledges the complex interactions in organizations.
- We want to prevent oral disease and improve oral health; the mouth however is not an independent phenomena - it is part of the human body that socializes in a certain culture and environment.
- Dental disease is complex and multi-factoral.

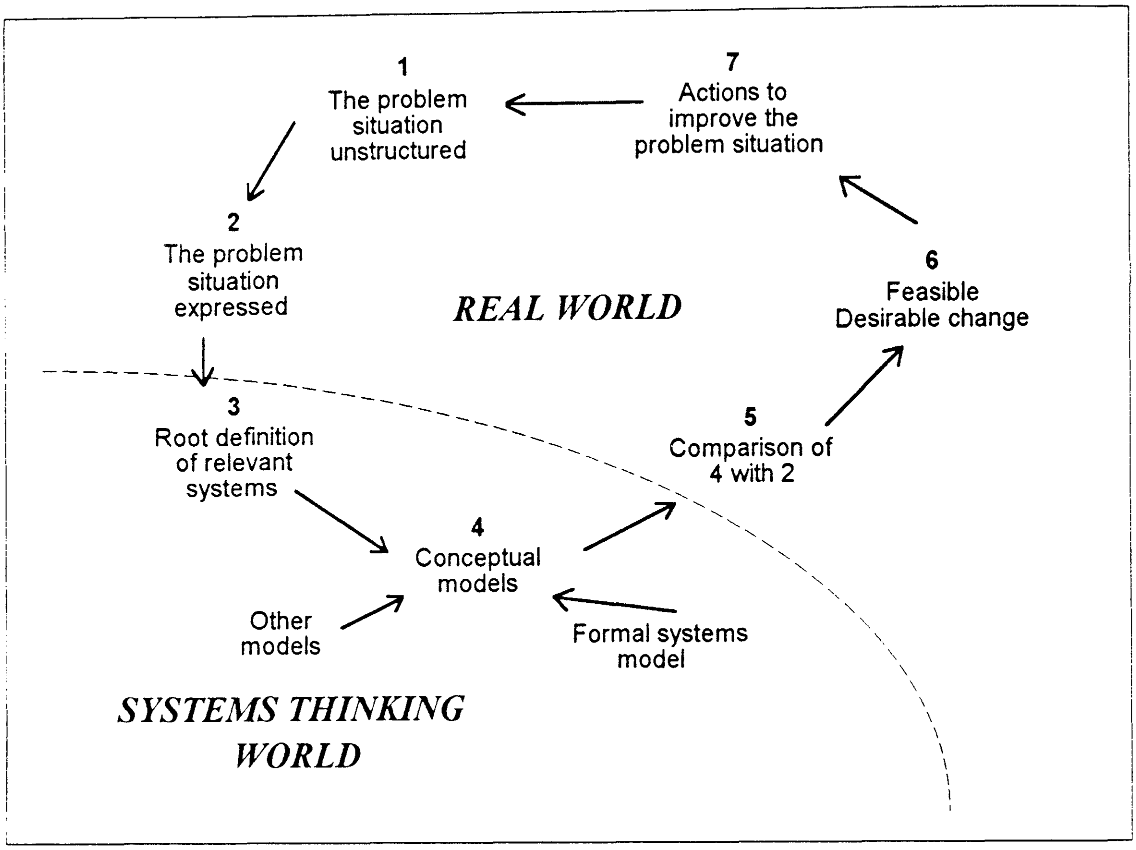

Figure 1.3 : Peter Checkland's Soft Systems Methodology (Adapted from Flood and Jackson, 1991, p 173)

The framework of the dissertation in connection with the SSM is presented in Figure 1.4.

8. Summary

This chapter sets the scene for some new thoughts in dental research and oral health care. The problem in the Oral Health Service of the SAMS is stated as a lack in prevention and oral health performance at the operational level. The rationale, significance and need for the study embrace the issues that real life problems need a systems approach, that prevention is better than cure and that performance can be improved by measurement. The aim, objectives and premise of the study are directed at the systems approach, the preventive project and performance measurement and improvement. The delimitations and limitations of the study were discussed and finally the approach to and the framework for the dissertation were justified and described. Chapter Two deals with a comprehensive situation analysis.

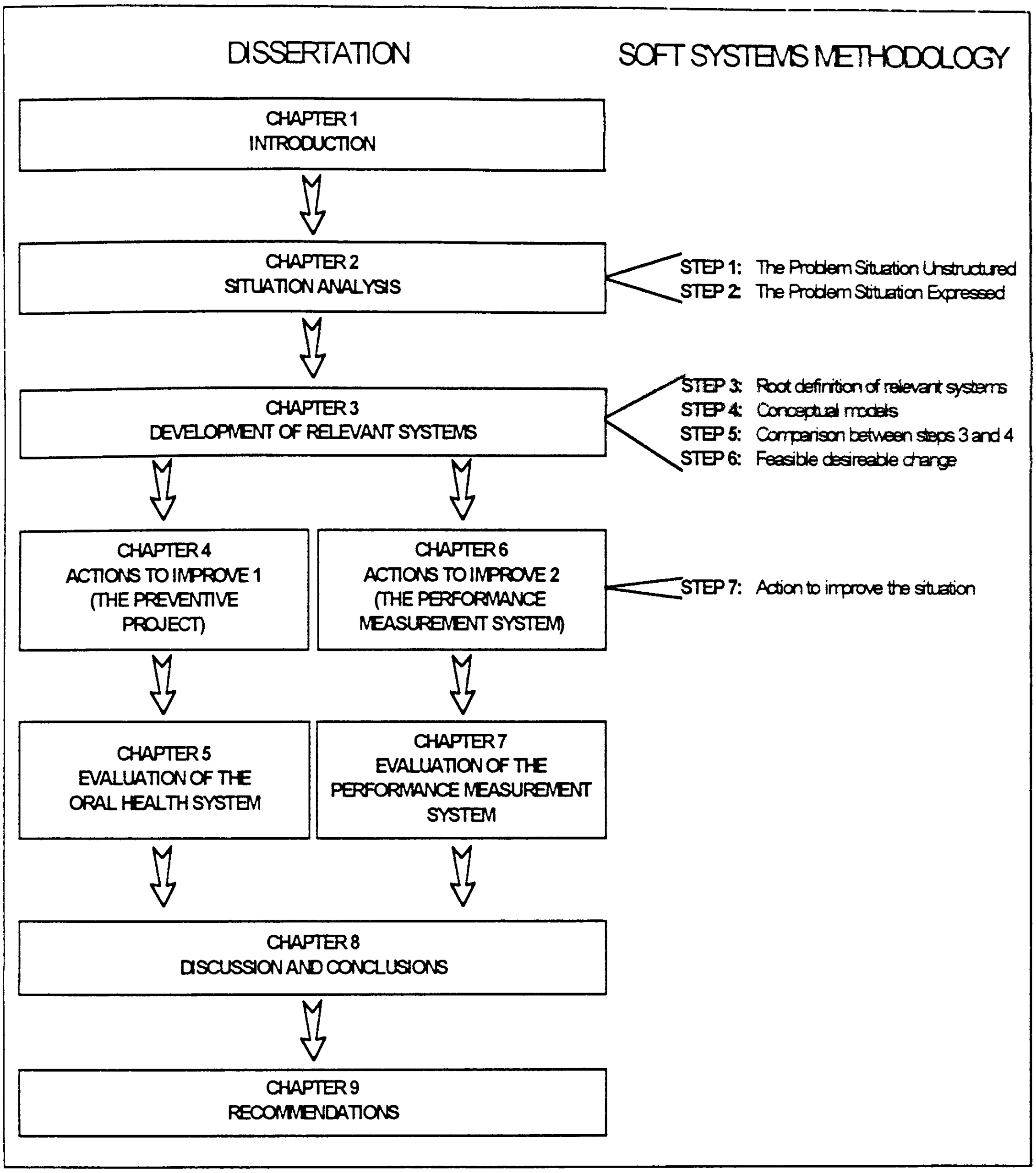

Figure 1.4: The framework of the dissertation and its orientation according to the Soft Systems Methodology of Peter Checkland.

CHAPTER 2

SITUATION ANALYSIS

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CHAPTER 2

SITUATION ANALYSIS

1. Introduction

Step 1 (The problem situation unstructured) and Step 2 (The problem expressed) of Checkland's Soft Systems Methodology (SSM) are discussed in this chapter. The function of these stages is to represent the current situation in such a way that it may lead to a range of possible options during the problem solving stage. Flood and Jackson (1991, p 172) describe three methods of information gathering in order to be able to present a "rich picture" of the real world situation (situation analysis). In this study a business economics approach to environmental scanning is used to gather information on the macro-, meso- and micro levels of the Oral Health Service of the SAMS. The elements of the business economics environmental scanning are discussed under the heading "The problem situation unstructured". Following this broad information scanning process, the author attempts to represent the problem by means of a SSM "rich picture". This chapter concludes with the identification of relevant systems.

To facilitate the reading and understanding of this chapter, and to clarify the link between the environmental scanning process and the representation of the SSM "rich picture" the contents of this chapter is schematically presented in Figure 2.1.

2. The problem situation unstructured

Issues having a possible influence on the rendering of oral health services in the SAMS are discussed under the headings Global trends, National economy, Indicators on the macro level, Indicators on the meso level, and Indicators on the micro level. The global trends are deliberated first.

2.1. Global trends

There are a number of global trends which will influence military health care in the near future. These trends can be observed in the organization, the priority of defence matters (from an international and national perspective), disease prevalence, and health care *per se*. Each is briefly discussed.

2.1.1. Trends within organizations

Internationally the relentless flow of information accumulates to the point where the world becomes borderless (Ohmae, 1990, p 214), and organizations respond to this by becoming information-based (Drucker,

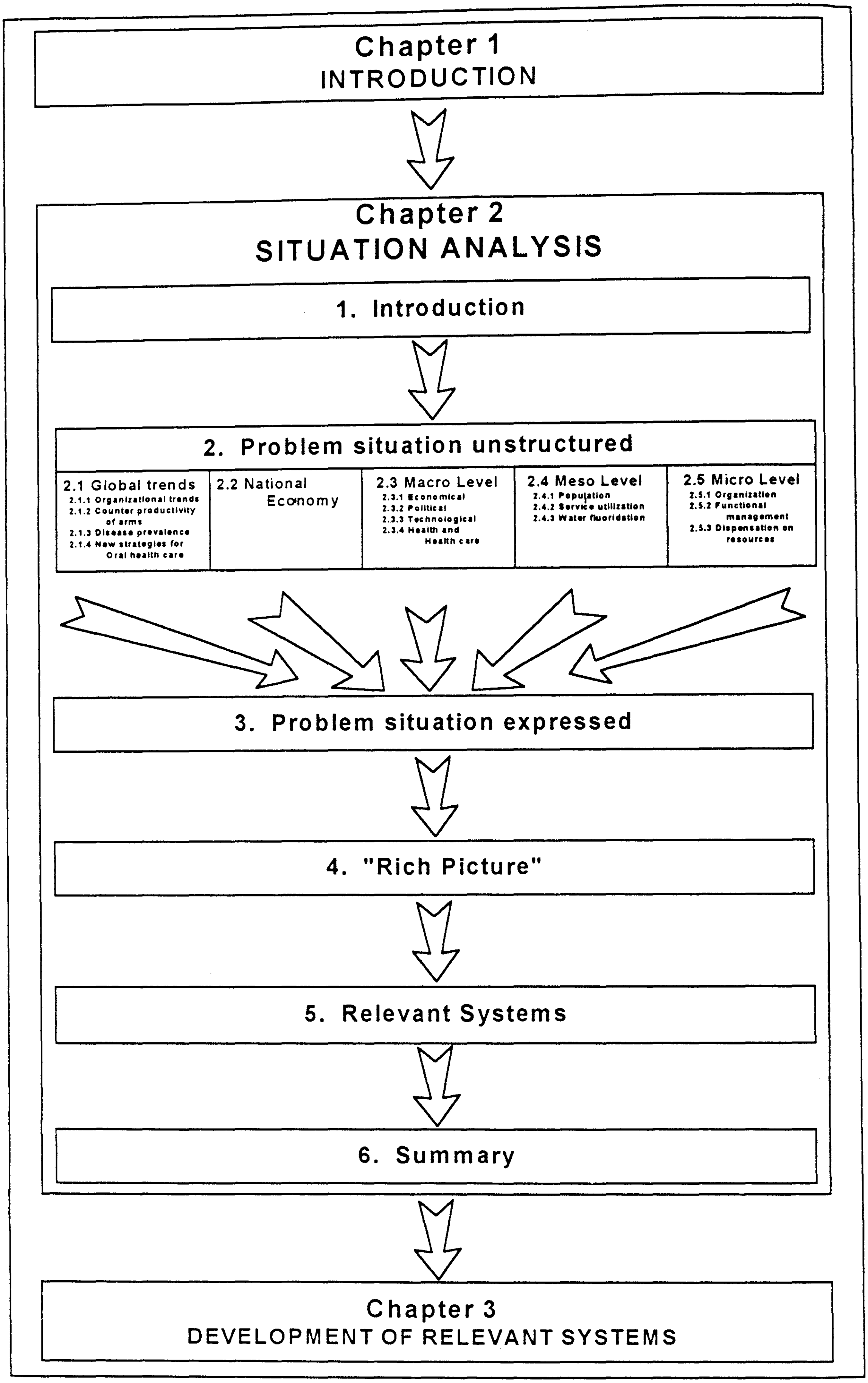

Figure 2.1: Conceptual framework of Chapter 2 and its orientation within the dissertation.

1989, p 169). These trends lead to new organizational forms, improved planning and decision making, and measurement of performance. Organizations have to "do more better" (Ohmae, 1990, p 62) and generate multiple approaches or strategies (Ohmae, 1990, p 80) in order to survive. We can reason that due to the availability of information the Oral Health Service of the SAMS will have to "do more better" by improved management; and performance will have to be quantified, measured and improved. If the Oral Health Service of the SAMS is not able to manage and use information they will no longer be competitive.

2.1.2. Counter productivity of arms

Drucker (1989, p 40) reasoned that arms in the international arena have become counter productive. The military has become a major drain on the economic performance and economic development of most countries. This situation will have to be addressed world-wide.

The Oral Health Service of the SAMS is funded via the national military budget. If the military budget is cut, the budget of the Dental service will also suffer.

2.1.3. Disease prevalence

In developed countries the prevalence of oral disease is gradually declining. In the developing world however dental caries is increasing or has the potential to increase (Figure 2.2) (Elderton, 1990, p 1).

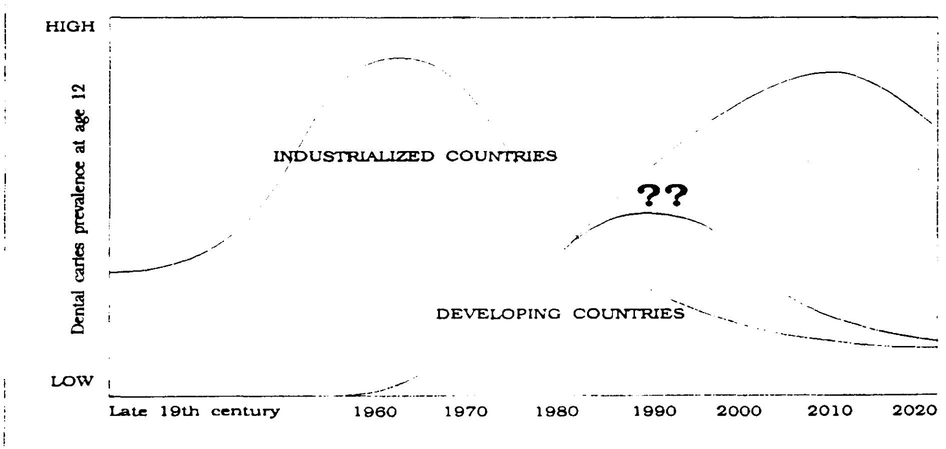

Figure 2.2: Schematic representation of the global prevalence of dental caries at age 12 years (Elderton, 1990, p 1)

Although the current population of the SADF might be positioned on the downslope of the graph on caries prevalence, we may expect a possible increase in prevalence as the ethnic composition of the SADF turns to a black majority membership.

2.1.4. Trends in oral health care

A significant effort is made worldwide to implement new and appropriate strategies in oral health care. The following main global trends concerning health care are discussed: [1] Health for all - Oral health for all; [2] Human resources; [3] Change towards prevention; [4] Problems in health care; and [5] Escalating health care costs.

2.1.4.1. Health for all - Oral health for all

The World Health Organization has set a goal *Health for all by the year 2000*. The underlying strategy by which this goal may be achieved embraces the concept of *primary health care*. Primary health care entails the availability of essential care where individuals live and work, combined with first-level care for communities (Elderton, 1990, p 53). It is implicit that this individual and family care should be based on practical, scientifically verified and socially acceptable methods and technology, made universally available through the full participation of the individuals in the community, and at a cost the community can afford and maintain.

The Oral Health Service of the SAMS will have to follow this primary oral health care surge in order to make oral health care more affordable, accessible and acceptable.

2.1.4.2. Human resources

A high prevalence of dental disease, a shortage of dentists and/or finances have led governments, even in developed countries, to offer dental care services to consumers by means of dental therapists and similar auxiliary para-dental operators. In a short time (2 to 3 years) dental therapists are trained to render primary preventive care and various treatments for children and adults, comprising most of the dental treatment carried out in a developing population (Elderton, 1990, p 64). The problem with dental therapists is that they tend to lack in motivation, and that oral health services still need the supervision of a well-motivated, energetic and determined dental officer (dentist) (Elderton, 1990, p 65). Elderton (1990, p 65) indicates that if the problems with dental therapists can be addressed and overcome, then their use in the provision of dental manpower is highly recommended in developing populations.

Furthermore, there is a trend to use other medical and non-medical personnel to provide primary preventive measures, e.g., paediatricians, obstetricians, gynaecologists, nurses, pre-school and school teachers, social workers and parents. With the use of these personnel the role of the dentist will become: [1] To provide instruction for medical and non-medical personnel; [2] To monitor preventive measures; and [3] To manage the secondary prevention of early caries and periodontal disease through regular care (Elderton, 1990, p 66).

On the management side there is a tendency for health professionals to participate in the management of hospitals. Greater freedom is given to local hospitals in public health sectors to determine not only how they manage staff but also what they pay them (Nelson, 1989, p175).

The Oral Health Service of the SAMS will shortly be faced with membership partly representing a developing population. With diminishing resources and a possible increase in disease prevalence it makes sense to make use of appropriate manpower in order to eliminate the onset of disease.

2.1.4.3. Change towards prevention

There is a world-wide tendency towards preventive policies and strategies. The aim of this change is to provide everyone with the opportunity to maintain a healthy, functional dentition, for life, by preventing what is preventable and by containing the remaining disease (or deformity) through the efficient use and distribution of intervention resources. This tendency accords well with modern concepts of the purpose of a publicly financed dental care system (Elderton, 1990, p 71).

Current curative oriented dental services will have to change to prevention in order to remain appropriate.

2.1.4.4. *Problems in health care*

Jacob and Plamping (1989, p 2) identified the following problems to be characteristic of oral health care systems, and should be of serious concern to managers promoting oral health:

- ⇨ The medical model is inadequate, incorrectly equating medical care with health care.
- ⇨ Unclear goals - a widespread but erroneous assumption of general agreement on what health is.
- ⇨ Maldistribution of resources in relation to need, emphasizing treatment over prevention.
- ⇨ Inaccessible services - planners focus only on availability and ignore accessibility, accommodation, affordability and acceptability.
- ⇨ Inequities in service delivery and use, with poor people needing services the most and using them the least.
- ⇨ Lack of accountability or any formal way for patients to influence health care planning.

Most of these problems also apply, to some extent, to the Oral Health Service of the SAMS. According to Jacob and Plamping these problems can be addressed by using a Primary Oral Health Care (POHC) approach. The Oral Health Service of the SAMS will have to embrace this POHC concept in its service strategy.

2.1.4.5. *Escalating health care costs*

Since 1970 western countries have seen an unprecedented rise in health care costs, exceeding twice the general inflation rate (Spier, 1982, p 8). Health expenditure constitutes a considerable and growing portion of state spending, without reducing overall morbidity or increasing the wellness of the population. On the one hand, there seems to be no clear indication regarding the ceiling on how much expenditure medical care can absorb and, on the other hand no community seems to be able to provide all the care its population might be willing to use (Spier, 1982, p 8).

SAMS experiences part of the health care cost dilemma and innovative strategies will have to be implemented to counter the hiking cost in the industry.

The global trends in Oral Health Care have been discussed. It is concluded that the Oral Health Service of the SAMS will have to embrace the Primary Oral Health Care approach in order to make oral health care more affordable, accessible and acceptable. Manpower should be utilized to eliminate the onset of disease, and a drastic change from merely curative care to prevention is needed in order to stay appropriate.

The global trends influencing oral health care in the Oral Health Service of the SAMS were deliberated. The following are concluded:

- ⇨ The Oral Health Service of the SAMS will have to do more better to stay competitive.
- ⇨ Due to the decline in the importance of the military, the Oral Health Service of the SAMS will have to be more efficient.
- ⇨ The change in the SADF population composition might cause an increase in the disease profile of the clientele.
- ⇨ The POHC approach will have to be applied in order to make the service more affordable, accessible, acceptable and appropriate.

These global trends are the changes propelling us into the next century. The trends dictate national economies and set the pace for change in organizations. The National Economy of South Africa is briefly deliberated next.

2.2. National economy

The national economy of South Africa is said to be market-based and consumer driven. The health care sector *per se* is divided into a ratio of 80:20 between the public- and private sector. Although the private sector services only about 20% of the market, it is also subject to numerous regulations regarding fees, competition, marketing possibilities and medical schemes. On a national level, the economy is unlikely to move in the direction of a free market system; state intervention is likely to increase. This could mean that the SAMS could be financed from a national health fund (probably a National Health Insurance). If health care resources are to be distributed by this means the budget and therefore the ability to render a treatment service will decrease.

The national economy of a country is the prevailing economic structure, climate and environment for business in the country. Within the national economy the macro-, meso and micro level indicators influence and guide organizations. The macro level indicators of the Oral Health Service of the SAMS are deliberated next.

2.3. Indicators on the macro level

Factors that will influence the Oral Health Service of the SAMS on a macro level are discussed under the headings Economical environment, Political environment, Technological environment, and Health and health care *per se*.

2.3.1. Economical environment

The prevailing economic climate, the economic system of a country and specific economic factors can be counted among the most powerful macro level determinants of health care systems (Van Rensburg *et al,* 1992, p 8).

The South African economy has now been in a recession for more than three years. This is more than double the 17 months average duration of cyclical downswing in the post-war era (Bureau for Economic Research, 1992, p 5). During 1991 and 1992 many traditionally reliable indicators suggested that the economy should have recovered - it did not. The upturn is expected to be slow and hesitant (Bureau for Economic Research, 1992, p 7).

The recessionary downswing described above has aggravated the main problem of the economy: a slow growth in production. This growth in production is measured by the growth in the gross domestic product (GDP). Figure 2.3 indicates the economic growth rates in real GDP since 1980 (CSS, 1992, p 21.5). With the increase in the population of 2,6% *per annum* (Department of Finance, 1992, p 2) it aggravated the unemployment situation. This low growth rate was influenced by declining world growth rates, the imposition of trade and financial sanctions and internal political instability.

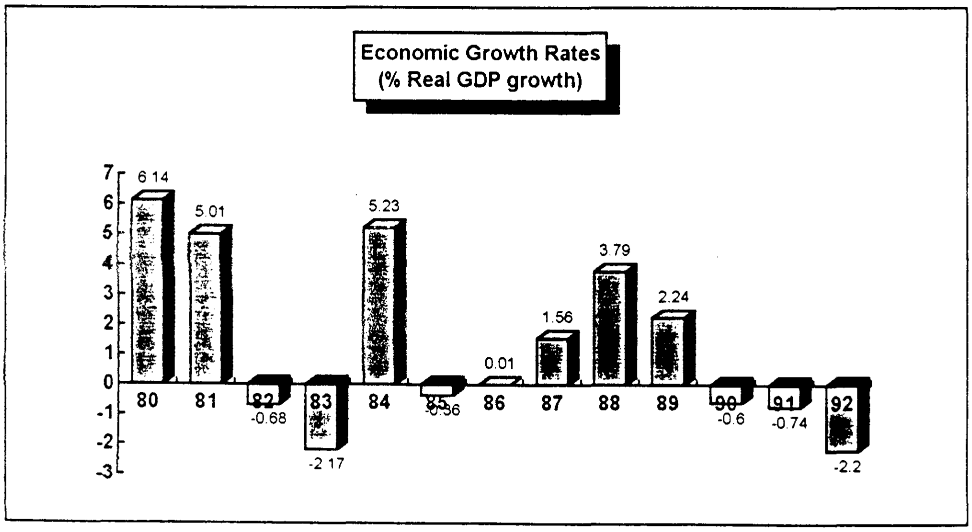

Figure 2.3: South African economic growth rates in percentage real Gross domestic product growth

The second main problem in the economy is the rate of inflation, especially for the health industry. A comparison between the rate of inflation, measured by the consumer price index for all consumer items, and medical care and health expenses is presented in Figure 2.4. It is clear that since 1988 the cost in the health care sector has been rising more rapidly than the average.

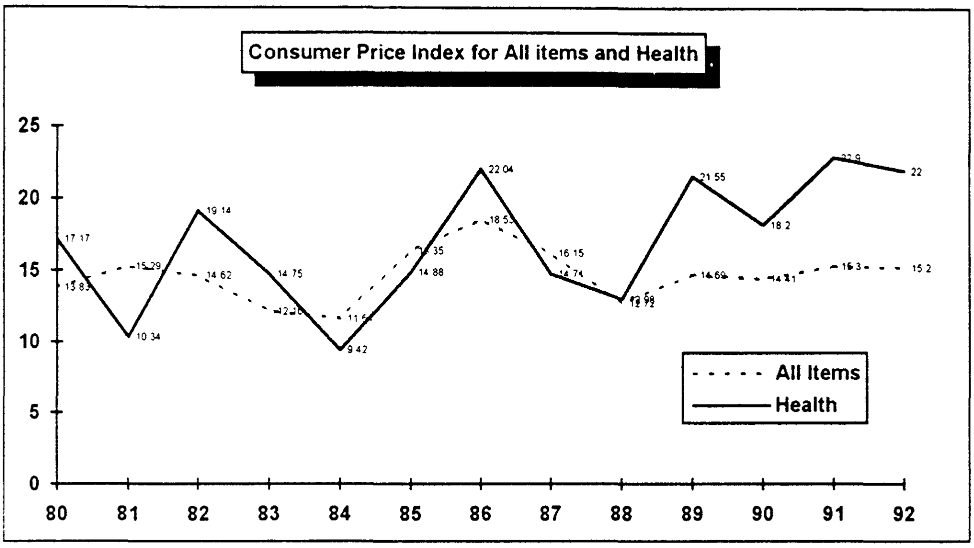

Figure 2.4: A comparison between the rate of inflation between All Items and Health Care cost in South Africa measured by the consumer price index (CSS, 1992, p 8.20)

The recession in the economy affects the SADF in so far as the decrease in the budget and the effect of inflation on the spending ability are concerned. Government expenditure on defence (the South African Medical Service is directly dependent on the defence budget) is steadily declining (Figure 2.5) and no change in the near future is anticipated, probably due to the global trend regarding the counter productivity of arms.

Figure 2.5 also indicates the effect of the declining defence budget and the rise in health care costs on the real spending ability of the South African Defence Force. It is clear that the spending ability is 30% less than in 1988. We can conclude that the South African Medical Service, and more specifically, the Directorate Oral Health will have to deliver the same output with a considerable decline in resources. Van Rensburg *et al* (1992, p 8) however states that an economic crisis often serves as a catalyst for reform measures and movements within a health system.

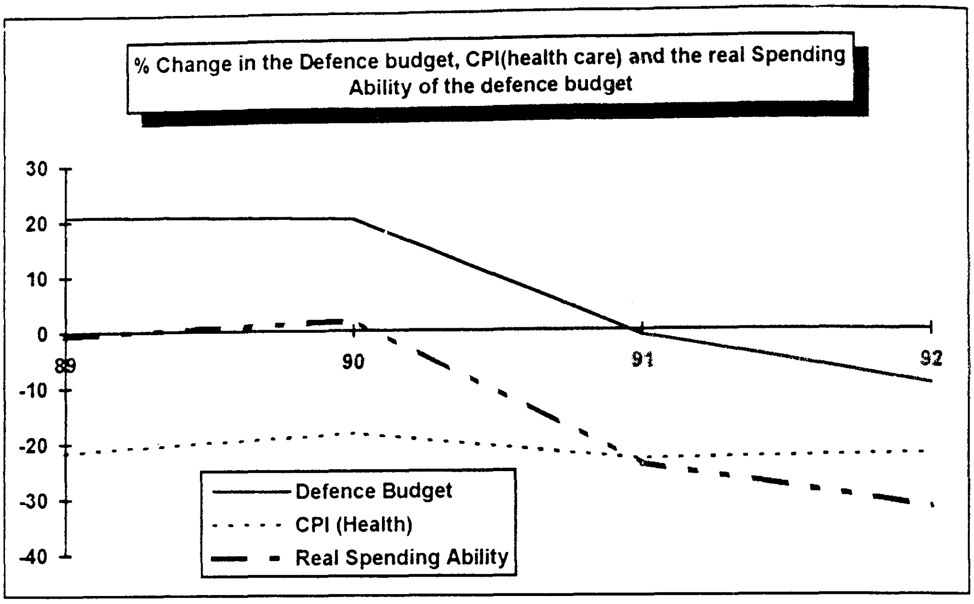

Figure 2.5: The effect of the declining defence budget and escalating health care costs on the real spending ability of the defence budget.

2.3.2. Political environment

According to Van Rensburg *et al* (1992, p 9) the prevailing political and government systems, the constitutional and statutory dispensations, political ideologies, policies and institutions, the demands and pursuits of political parties and pressure groups, and political change and revolutions which occur in societies are generally reflected in and influence health care systems of that country. There are a few issues in the political environment needing a brief discussion, namely: [1] The fragile unstable situation; [2] The democratic wave; and [3] The demand for health care for all.

According to Tucker and Scott (1992, p 36) South Africa's political situation is fragile. The negotiations on a new political dispensation are supported by a number of positive factors, particularly among the high-level negotiating partners. Negative factors such as the economic decline and endemic violence however pose a threat to positive solutions. The same authors sketch preliminary scenarios depending on the performance of the economy (Figure 2.6). With the deliberation on the national economy we can conclude from Figure 2.6 that the regime after the period of transition will have to be authoritarian in order to stabilize the fragile situation.

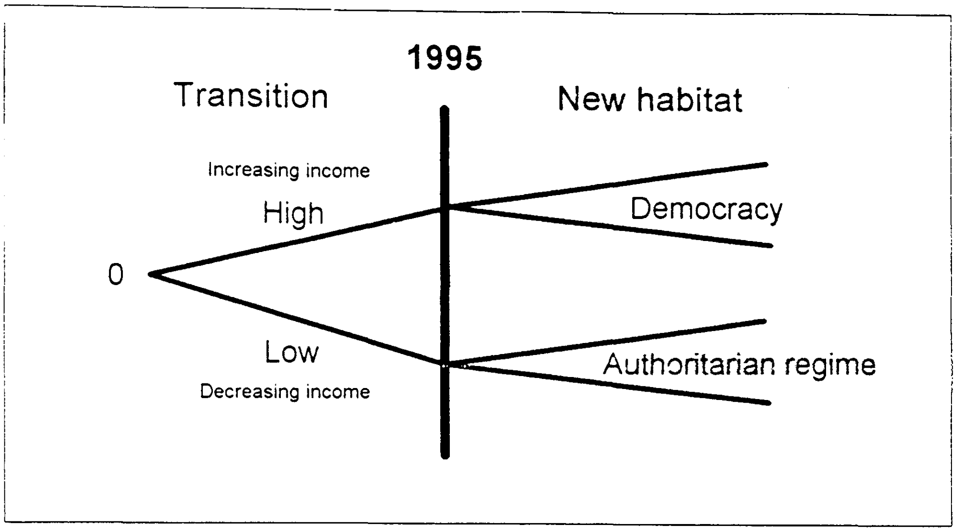

Figure 2.6: Preliminary scenarios (Tucker and Scott, 1992, p 37)

Except for the instability in South African politics since 2 February 1990, the dominant prevailing issue is probably the move to a more democratic South Africa. The previously politically ignored millions could dictate the priorities of the future, and the distribution of national resources will be challenged by different and new horizons. These changes can be positive if the controlling regime is strong enough to control the sweeping wave of unrealistic demands caused by an upheaval of democracy.

Furthermore there are a few important political demands on health care in South Africa, namely (Coovadia, 1990, p 24): [1] Access to health care is a basic human right; [2] Equity - there must be fairness in availability and accessibility of health services and the ability to pay for services must play no part whatsoever in access to these services; [3] Rural services - these areas must rapidly attain levels of care appropriate to the population they serve, at least comparable to services available in urban centres; [4] Affirmative action - historical inequities must be reversed in education and training of health personnel and in delivery of health care; [5] A subcontinental perspective should be developed after appropriate consultation, with regard to needs for high-tech, expensive and tertiary facilities; [6] National Health Service (Zwarenstein, 1990, p 30) ; and [7] National Health Insurance (De Beer and Broomberg, 1990, p 26).

These political issues will burden the available health care resources. Resources will probably be redistributed on a national level. Every citizen will be entitled to his or her fair portion of the available health care "cake". This implies again that the health care budget of the SAMS will be slashed.

2.3.3. Technological environment

The oral health industry is technologically well equipped on all levels of care, namely primary, secondary and tertiary care. Although technology on the primary care level is well documented in the dental literature, oral health services tend to neglect their use (for instance the use of pit and fissure sealants in community programmes). The latest technology being introduced to dentistry is the application of the laser. The laser is currently used for both hard and soft tissue procedures, and the possibilities to prevent dental caries in an efficient and effective way are promising (Viljoen and Rossouw, 1993, p 19).

It is concluded that the Oral Health Service of the SAMS will have to make use of available technology on the primary care level in order to make oral health care more affordable.

2.3.4. Health and health care

Health and health care as a broader concept than oral health and oral health care, are seen as indicators on the macro level because general health influences oral health, which is on a meso level. The health status of the SADF population is described by use of national health status indicators. The following indicators are discussed: [1] Life expectancy; [2] Infant mortality rates; and [3] Infectious disease. After the discussion on the health indicators a short deliberation on the health care situation within the SAMS is presented.

2.3.4.1. Life expectancy at birth

This is a representative indicator of the general health status of a population (Dept of National Health and Population Development, 1991, p 1). It reflects the number of years a new-born infant would live if patterns of mortality prevailing at the time of birth were to stay the same throughout life.

The World Bank estimates of life expectancy at birth for countries by income group are as follows (Dept of National Health and Population Development, 1991, p 1):

Low Income Countries	61,1 years
Lower-middle Income Countries	64,0 years
Upper-middle Income Countries	67,3 years
High Income Countries	76,1 years

South Africa is considered to be a lower-middle income country and the average life expectancy of 64 years is thus within the expected norm. The average life expectancy for South Africa and various other regions are compared in Figure 2.7.

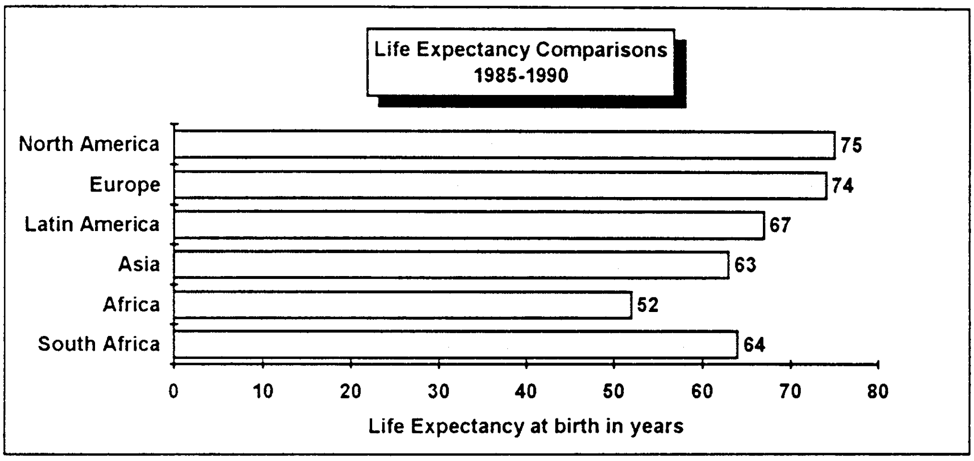

Figure 2.7: The average life expectancy of South Africa compared to other regions (Dept of National Health and Population Development, 1991, p 1)

2.3.4.2. *Infant mortality rates*

According to the Department of National Health and Population Development (1991, p 3) the health of infants is sensitive to a variety of environmental and individual factors. The infant mortality rate is therefore a useful tool in gaining a general impression of health and development of a population. Infant mortality rate is usually defined as the annual number of deaths of infants under one year of age per 1000 live births during the same period (Dept of National Health and Population Development, 1991, p 2). The average infant mortality for South Africa in 1990 was estimated to be 47. Figure 2.8 compares the South African infant mortality rate with those in other WHO regions of the world (Dept of National Health and Population Development, 1991, p 3).

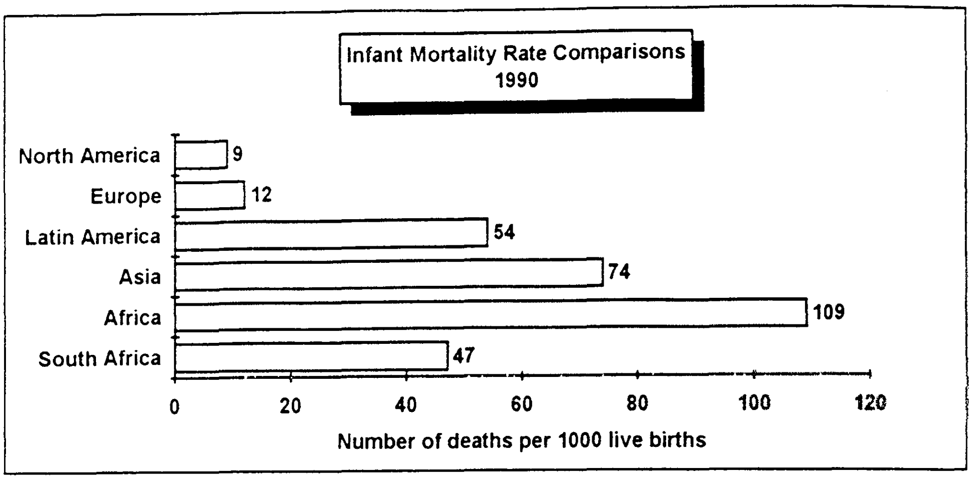

Figure 2.8: A Comparison between the infant mortality rates of South Africa and other WHO regions (Dept of National Health and Population Development, 1991, p 3)

It is clear from Figure 2.8 that although the number of deaths per 1000 live births is much lower in South Africa than in Africa and Asia there is still a long way to go to the level of developed countries.

2.3.4.3. *Infectious disease*

The proportion of deaths due to infectious and parasitic disease is an indicator of the general health situation in a population (Dept of National Health and Population Development, 1991, p 27). Figure 2.9 indicates the situation in the four population groups of South Africa from 1978 to 1990.

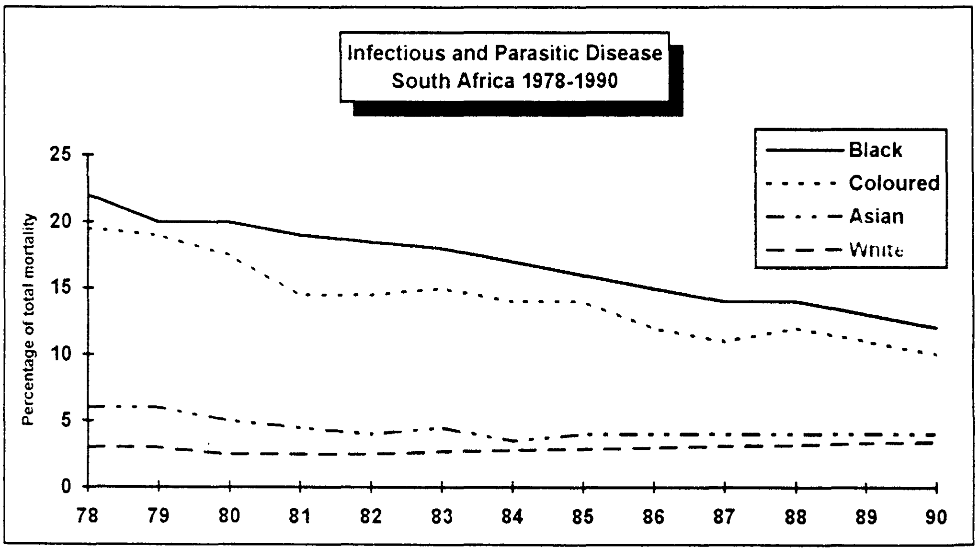

Figure 2.9: Proportion of deaths due to infectious and parasitic disease in the four population groups of South Africa from 1978 to 1990 (Dept of National Health and Population Development, 1991, p 27).

Although Figure 2.9 demonstrates a decline in the percentage infectious and parasitic disease contributing to the total mortality of the South African population, the average is still above ten percent. This indicates a relatively low level of general health in the total population. With this background of the health status of the population of South Africa the health care in the SAMS is deliberated next.

2.3.4.4. Health care in the SADF

The South African Medical service renders a comprehensive health service to the population of the SADF, their dependants, SADF pensioners and other small groups. All the disciplines within the health sector are represented such as medical care (including specialists), dental care (including specialists), psychology, pharmaceutical, nursing, dietary services, biokinetics, and environmental health services. Services are primarily rendered at military hospitals, military clinics and sickbays. Community nurses render a service in the community to the elderly, the disabled and new born babies where possible. Thus the services are mainly based upon secondary and tertiary levels of care. Little emphasis is placed upon primary care and health *per se*.

The SAMS treats approximately 1 301 000 patients a year. This indicates an average of 5 visits per potential patient per annum. Figure 2.10 illustrates the proportional number of contacts in the primary, secondary and tertiary levels of care (Welgemoed, 1992, unpublished).

The scope of treatment in the SAMS is very typical of a developed population, being fairly evenly distributed between the main medical disciplines. Table 2.1 summarizes the number of consultations per discipline as a proportion of the total.

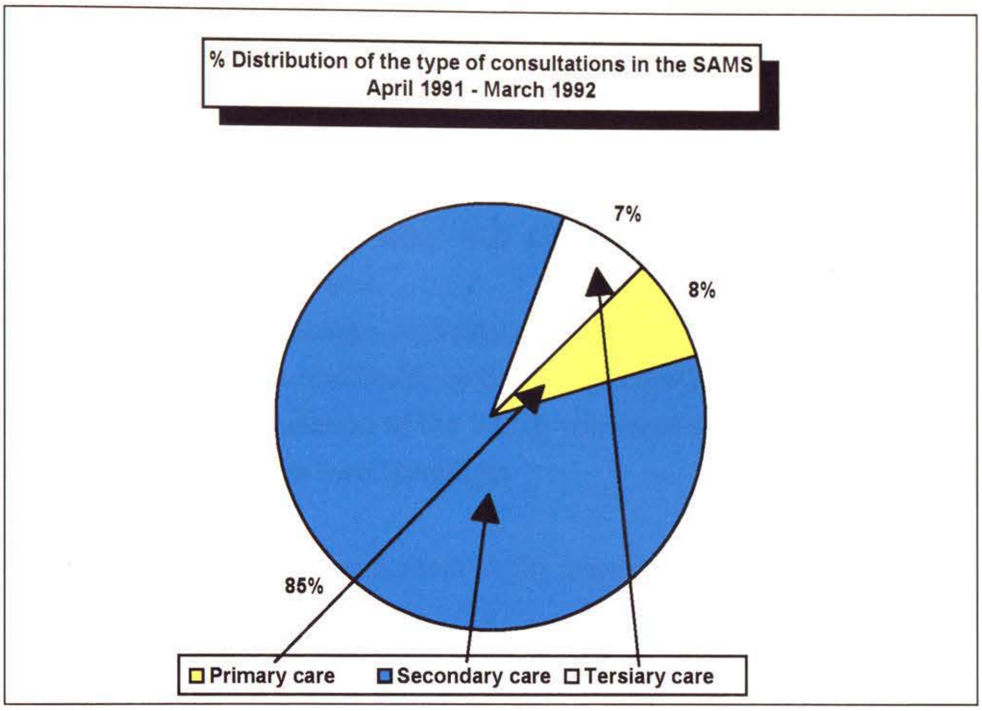

Figure 2.10: An illustration of the proportional distribution of the type of consultation in the SAMS (Welgemoed, 1992, Unpublished)

Type of consultation	Number	% of total
Cardiology	29 930	2.299
Dermatology	42 867	3.294
Ear, Nose and Throat	73 780	5.669
General medicine	559 714	43.011
General surgery	35 918	2.760
Obstetrics and Gynaecology	48 361	3.716
Neuro Surgery	2 166	0.166
Neurology	9 463	0.727
Ophthalmology	22 821	1.753
Orthopaedics	166 808	12.818
Other	188 119	14.456
Paediatrics	73 471	5.645
Plastic surgery	3 483	0.267
Psychiatry	10 797	0.829
Psychology	12 918	0.992
Urology	20 701	1.591
TOTAL	1 301 317	100.000

Table 2.1: The number of treatments per discipline (Welgemoed, 1992, Unpublished)

It is concluded that the SAMS renders a typical "industrialized population care". This situation will have to change seeing that the population of the SADF will rapidly change to a health profile of a developing community.

To conclude, the macro level indicators were identified to be the following:

- ⇨ The prevailing economic situation will force the SAMS to deliver approximately the same output with a vast decline in resources.
- ⇨ The political issues will further burden national resources and a redistribution of the available "health care cake" will definitely leave the SAMS in an inferior situation to the present.
- ⇨ There is however, technology available on the primary care level that can help the SAMS to make oral health care more affordable.
- ⇨ The changes in the population of the SADF will force the SAMS to change its "developed population care" paradigm.

The discussion now moves to the indicators on the meso level.

2.4. Indicators on the meso level

Meso level indicators are discussed under the headings Population (Clientele), Oral health status, Utilization of services and Water fluoridation. (The term clientele is used and is defined by Van Rensburg *et al* (1992, p10) as those persons at the receiving end or on the consumer side of the services or facilities. It more specifically refers to the patient population whose care needs are, or have to be provided by a specific health care system. This clientele is also regarded as the need or demand side of the health care system (Van Rensburg *et al,* 1992, p 11).

2.4.1. Clientele (Population)

According to Van Rensburg *et al* (1992, p 10) the demographic composition and dynamics of the population have a direct effect on the health care system. The demographic structure of the population, the way the population relates to its natural environment (e.g. high rate of urbanization) and how this environment is utilized (e.g. high degree of industrialization) would all influence the health care system. The general expectation is that the health care system would reflect the needs of its target population (Van Rensburg *et al,* 1992, p 10). The demographic characteristics and the oral health status of the clientele are discussed next.

2.4.1.1. Demographic characteristics

2.4.1.1.1. The size of the SADF population

The total size of the clientele of the SAMS is approximately 220 000. Figure 2.11 illustrates the proportional distribution between the army, the airforce, the navy and the medical services, indicating the army as the largest end user of the system. Figure 2.12 illustrates the proportional distribution between the main groups namely the uniformed personnel, the adult dependants, the children dependants and the pensioners, indicating that the uniformed personnel contributes 87 percent to the total care responsibility.

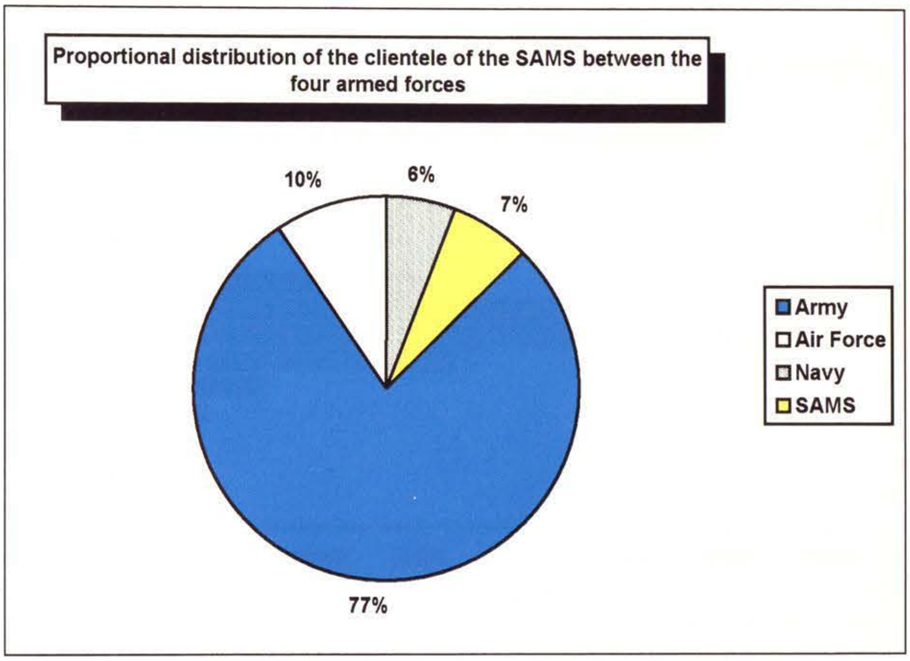

Figure 2.11: A proportional distribution of the clientele of the SAMS between the four armed forces namely the Army, the Air Force, the Navy and the South African Medical Services.

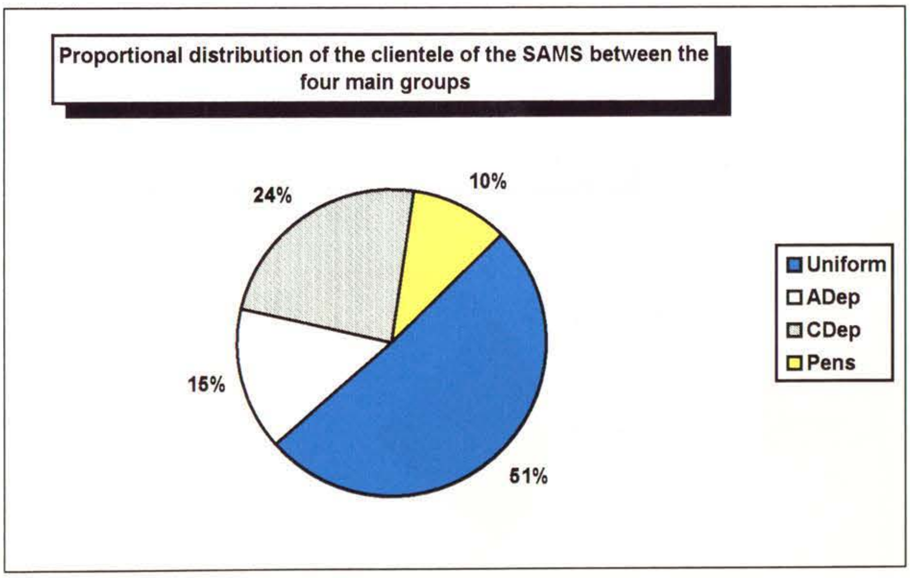

Figure 2.12: A proportional distribution of the clientele of the SAMS between the four main population groups namely the Uniformed personnel, the Adult dependants, the Children dependants and pensioners.

Having established that the majority of patients are uniformed army personnel and secondly children dependants, the discussion moves to the age and gender structure of the clientele.

2.4.1.1.2. The age structure

The age structure of the SADF population is illustrated in Figure 2.13.

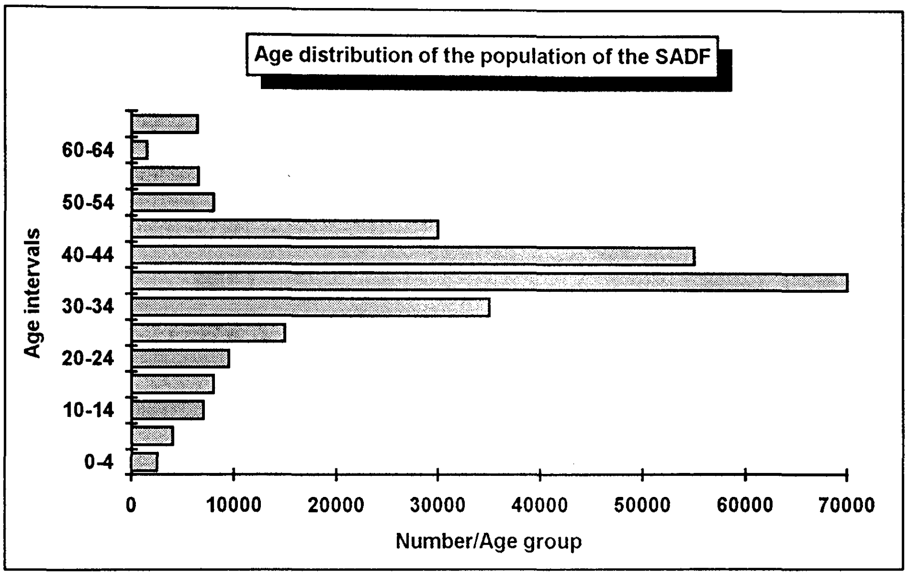

Fig 2.13: The age structure of the total SADF population in 5 year intervals.

2.4.1.1.3. The gender structure

The gender structure of the SADF population is illustrated in Figure 2.14.

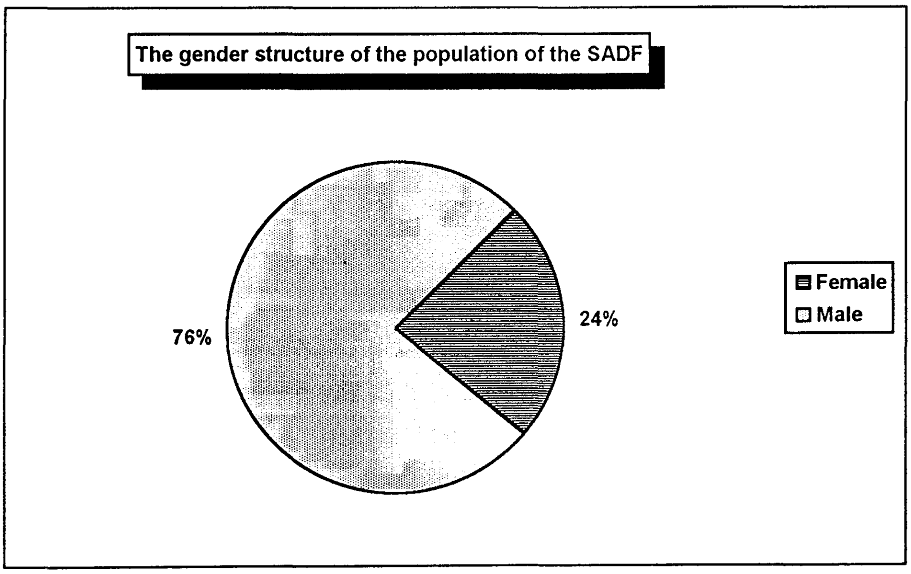

Fig 2.14: The gender structure of the total SADF population, indicating the male predominance.

2.4.1.1.4. The spatial distribution

The spatial distribution of the SADF population is illustrated (Figure 2.15) according to the 10 medical commands that are responsible for the SADF population in that geographical area.

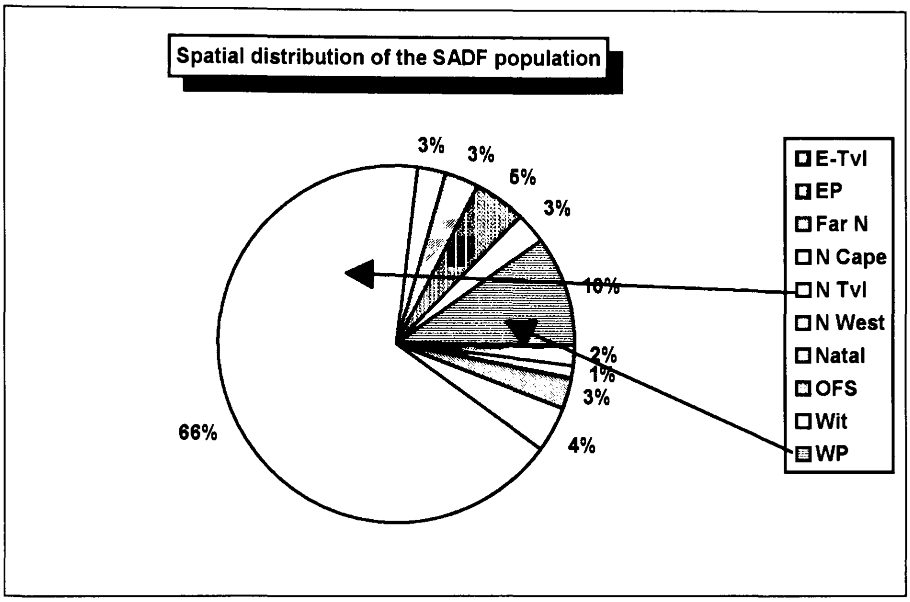

Fig 2.15: The spatial distribution of the total SADF population according to the ten Medical commands (E-Tvl=Eastern Transvaal; EP=Eastern Province; Far N=Far North; N Cape=Northern Cape; N Tvl=Northern Transvaal; N West=North West; Natal=Natal; OFS=Orange Free State; Wit=Witwatersrand; WP=Western Province).

Figure 2.15 shows that the majority of the clientele stays in and around Pretoria.

2.4.1.1.5. The population composition

The population composition of the SADF population is illustrated in Figure 2.16, and shows that the majority of the population is caucasian. The proportion of black SADF members will however increase. It is concluded that the Majority of the patients can demographically be described as: uniformed; Army; male; age 35-44, stays in Pretoria; and is caucasian at this stage. The second largest group is the children of mostly Army members who stay in Pretoria.

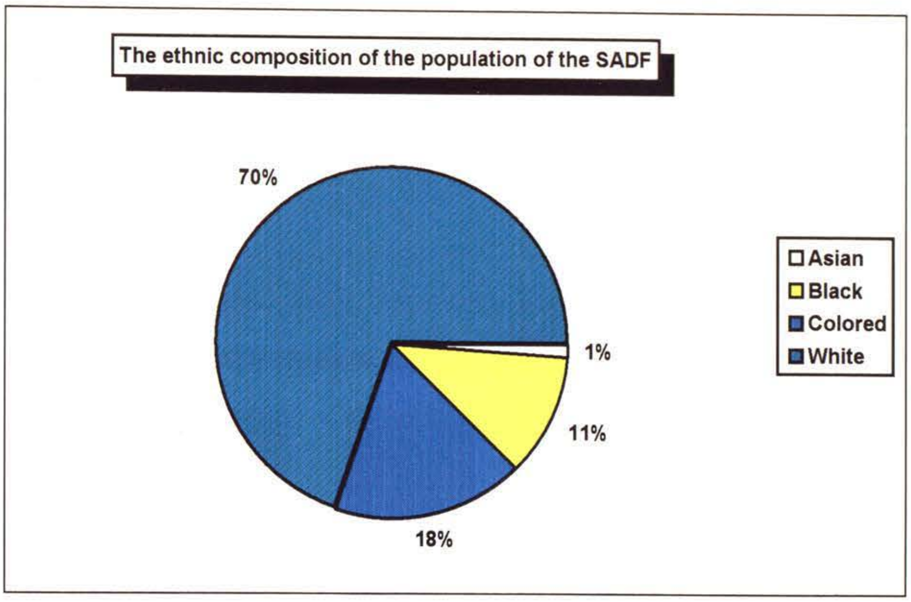

Fig 2.16: The racial-ethnic composition of the total SADF population, indicating the white majority.

The discussion now moves to the description of the oral health status of the clientele.

2.4.1.2. Oral health status

The oral health status refers to the standard of oral health, or otherwise to the level of oral disease of the population concerned (Van Rensburg *et al,* 1992, p 12). Dental caries and periodontal disease in the SADF population are briefly discussed.

2.4.1.2.1. Dental caries

The prevalence of dental caries in the population of the SADF is discussed under the headings percentage of the population affected by and free from dental caries experience, the mean DMFT score per population group, DMFT per tooth in the children group and the percentage distribution of carious teeth.

2.4.1.2.1.1. Percentage of the population affected by and free from dental caries experience

The percentage of the population affected by (or free from) dental caries is shown in Figure 2.17. Note the difference between the children dependants and the three adult population groups. Although 24,8% of the children dependant group (mean age = 13,14 years) were caries free at the time of the 1987/88 survey, we can argue (according to Ripa 1985, p 368) that this population group will show a decline in their oral health status by the time they reach adolescence. Ripa (1985, p 368) also indicates that the decline in caries free children is caused by decay of the pits and fissures, which indicates the need for fissure sealants despite the world-wide decline in the prevalence of dental decay.

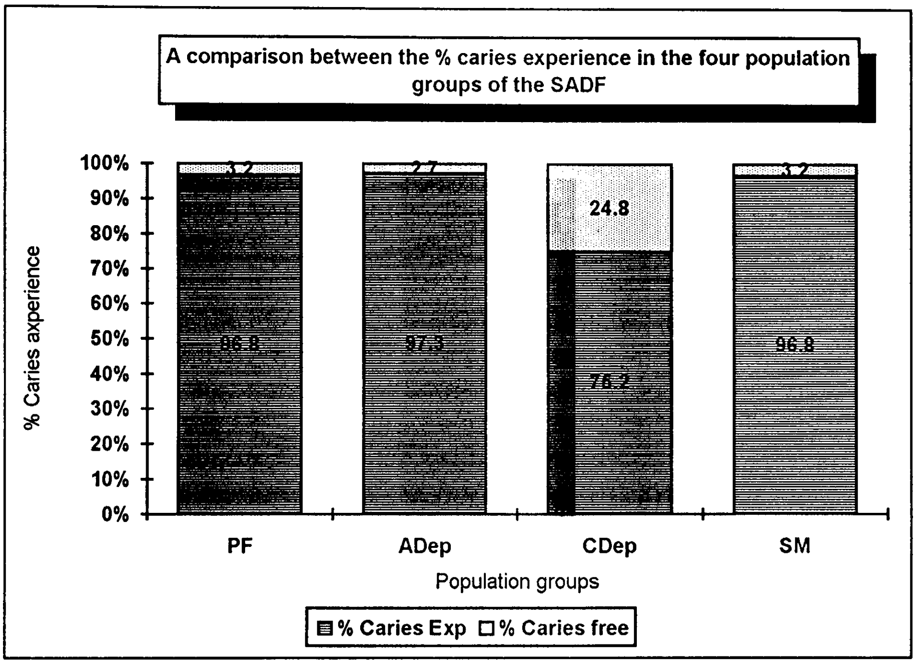

Figure 2.17: A comparison of the percentage caries experience in the four population groups of the SADF (PF=Permanent force; ADep=Adult dependants; CDep=Children dependants; SM= Service men) (Rossouw, 1989, unpublished).

2.4.1.2.1.2. Mean DMFT per population group

Figure 2.18 shows the caries status of the four population groups of the SADF using total DMFT scores. Note the moderate DMFT score in the children dependant population - indicating the need and priority for prevention in this group.

Figure 2.19 compares the proportion of the DT, MT and FT component of the DMFT scores in the different population groups. Note the high mean number of decayed teeth in the children dependant population. This high DT score indicates the activity and morbidity of dental decay in this group. It also indicates the poor utilization of services, which will actually only change the DT component to a FT component, and will therefore not cause a real difference in the oral health status.

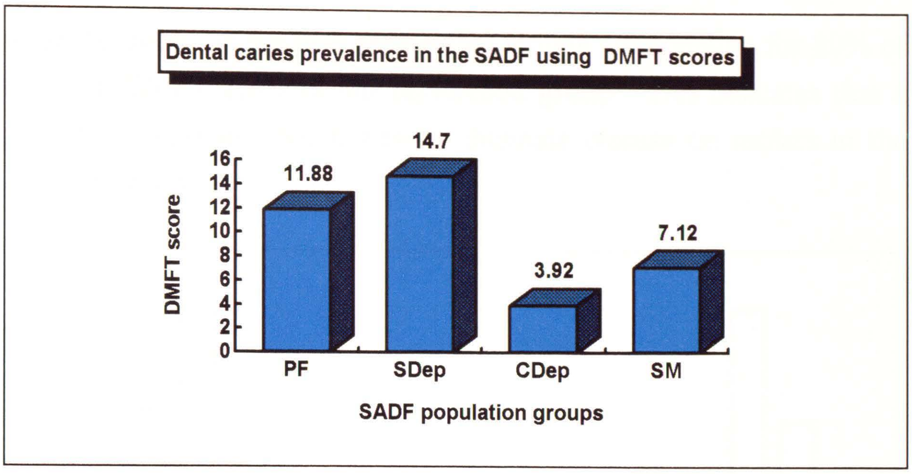

Figure 2.18: Dental caries prevalence in the four population groups of the SADF (PF=Permanent force; ADep=Adult dependants; CDep=Children dependants; SM= Service men) measured by DMFT (Rossouw, 1989, unpublished)

The deliberation in the previous paragraph again stresses the need to make the service more accessible and the urgency of preventing disease.

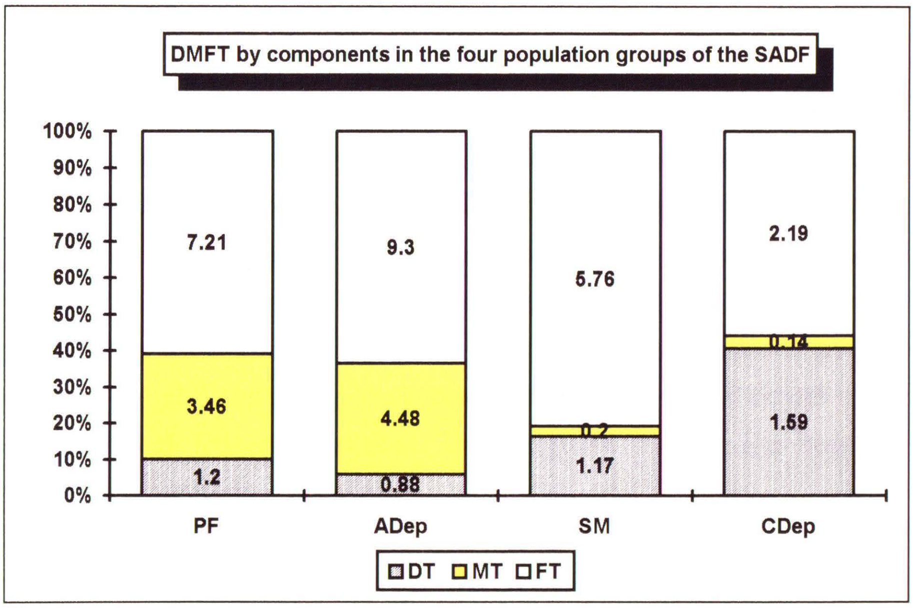

Fig 2.19: The prevalence of dental caries in the four population groups of the SADF (PF=Permanent force; ADep=Adult dependants; CDep=Children dependants; SM= Service men) measured by DT, MT and FT (Rossouw, 1989, unpublished)

2.4.1.2.1.3. DMFT per tooth in the children group

The distribution of dental caries relative to the different teeth of the children group is illustrated in Figure 2.20. Note the high prevalence of dental decay on the first and second molars - accounting for 80% of the total DMFT score in this population group. This indicates that a preventive strategy should aim to eliminate disease on molars in the children group.

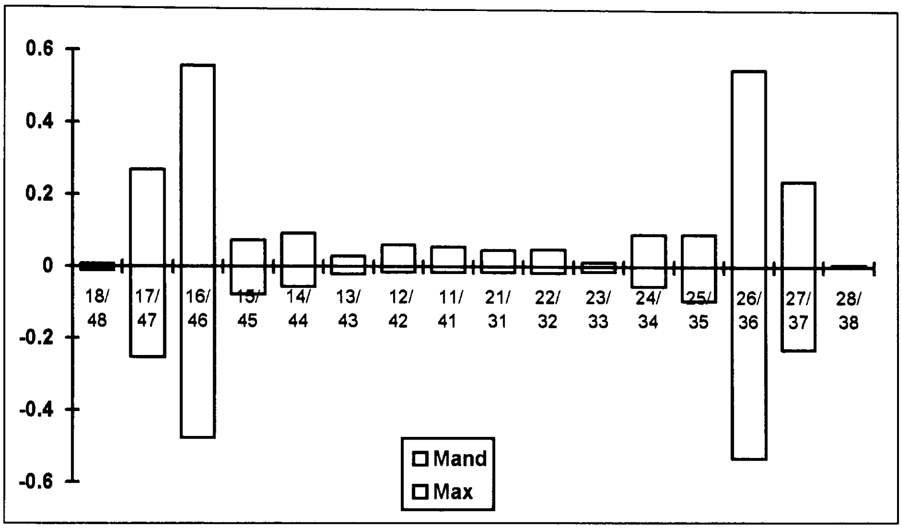

Figure 2.20: The distribution of dental caries relative to the different teeth in the children dependant group of the SADF (Rossouw, 1989, unpublished).

2.4.1.2.1.4. Percentage distribution of individual carious teeth

The distribution of dental caries within the different population groups closely follows the 80:20 rule. Table 2.2 indicates that: (1) 22% of the Permanent Force population is responsible for 40% of the dental caries of that population; (2) 23% of the adult dependant population is responsible for 46% of the dental caries in that population; and (3) 18% of the children group is responsible for 48% of the dental caries experience in that population. These figures indicate the need for selective prevention strategies.

2.4.1.2.2. Treatment needs for dental caries

2.4.1.2.2.1. Percentage of the population with treatment need

Figure 2.21 illustrates the percentage of the four population groups of the SADF who need and do not need treatment due to dental caries and also compares the treatment needs with the components of the DMFT scores. Note the difference in all the adult groups between the relative proportion of DT to percentage of treatment need. This is probably an indication of the "short life time" of he "traditional fillings". It is thus clear that preventing dental caries is not only preventing the first restoration, but it is also preventing the ongoing process of filling replacement.

Permanent Force				Adult Dependants				Children group			
C/Freq	%	C/ DMFT	%	C/Freq	%	C/ DMFT	%	C/Freq	%	C/ DMFT	%
31	3.22	0	0.00	31	29.81	0	0.00	132	24.81	0	0.00
50	5.19	19	0.17	32	30.77	1	0.09	182	34.21	50	2.60
73	7.57	65	0.57	33	31.73	5	0.45	240	45.11	166	8.63
97	10.06	137	1.20	34	32.69	10	0.91	292	54.89	322	16.74
125	12.97	249	2.17	36	34.62	24	2.18	357	67.11	582	30.24
151	15.66	379	3.31	39	37.50	48	4.35	398	74.81	787	40.90
190	19.71	613	5.35	44	42.31	93	8.43	436	81.95	1015	52.75
235	24.38	928	8.10	45	43.27	103	9.34	458	86.09	1169	60.76
314	32.57	1560	13.62	47	45.19	125	11.33	487	91.54	1401	72.82
382	39.63	2172	18.97	54	51.92	209	18.95	502	94.36	1536	79.83
435	45.12	2702	23.59	59	56.73	274	24.84	507	95.30	1586	82.43
496	51.45	3373	29.45	65	62.50	358	32.46	512	96.24	1641	85.29
549	56.95	4009	35.01	69	66.35	418	37.90	518	97.37	1713	89.03
598	62.03	4646	40.57	74	71.15	498	45.15	521	97.93	1752	91.06
652	67.63	5402	47.17	80	76.92	600	54.40	524	98.50	1794	93.24
707	73.34	6227	54.37	85	81.73	390	62.56	525	98.68	1809	94.02
754	78.22	6979	60.94	92	88.46	823	74.61	530	99.62	1889	98.18
791	82.05	7608	66.43	96	92.31	903	81.87	531	99.81	1906	99.06
825	85.58	8220	71.78	97	93.27	924	83.77	532	100.00	1924	100.00
854	88.59	8771	76.59	99	95.19	968	87.76				
878	90.87	9211	80.43	100	96.15	992	89.94				
892	92.53	9547	83.37	101	97.12	1019	92.38				
901	93.46	9745	85.09	104	100.00	1103	100.00				
906	93.98	9860	86.10								
907	94.09	9884	86.31								
915	94.92	10084	88.05								
917	95.12	10136	88.51								
964	100.00	11452	100.00								

C/Freq = Cumulative population frequency
% = Cumulative percentage
C/DMFT = Cumulative DMFT

Table 2.2: The percentage distribution of dental caries within the population groups of the SADF (Rossouw, 1989, unpublished).

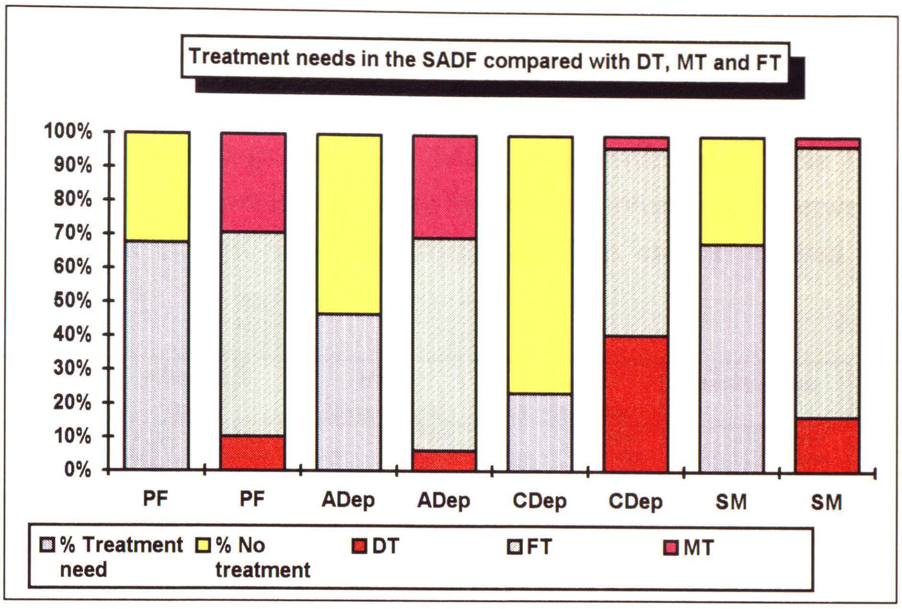

Figure 2.21: The percentage of treatment needs and percentage of no need compared with the DT, MT and FT components of the DMFT scores in the four population groups of the SADF (PF=Permanent force; ADep=Adult dependants; CDep=Children dependants; SM= Service men) (Rossouw, 1989, unpublished).

Figure 2.22 compares the treatment need in the four population groups indicating the average number of teeth per mouth with the need for restorations, the need for extractions and other treatment needs.

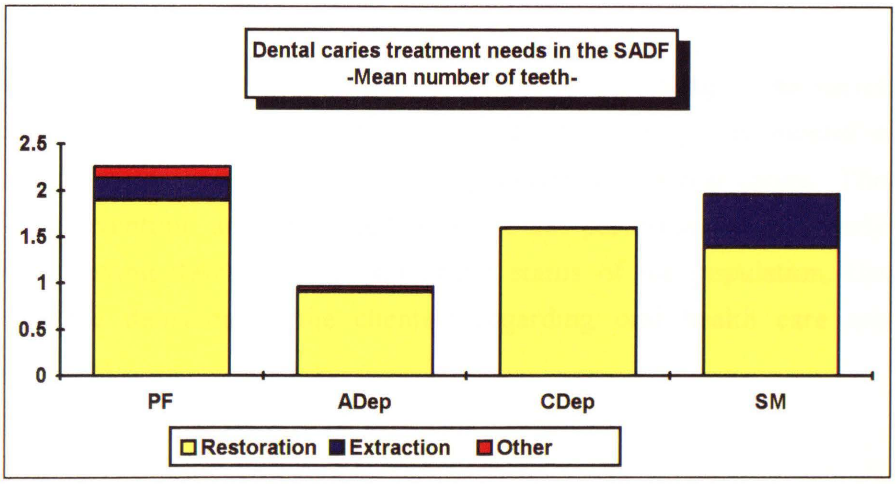

Figure 2.22: A comparison of the treatment needs in the four population groups of the SADF (PF=Permanent force; ADep=Adult dependants; CDep=Children dependants; SM= Service men) (Rossouw, 1989, unpublished).

Figure 2.22 also illustrates the massive curative backlog in the clientele as well as the urgent need for prevention.

2.4.1.2.3. Periodontal disease

The prevalence, severity and treatment needs of periodontal disease in the four population groups of the SADF are summarized in Table 2.3. This table clearly indicates the need for primary prevention, as between 88 and 100 percent of all periodontal problems can be resolved by primary care.

Indicator	Permanent force		Adult Dependants		Children dependants		Service men	
	% of population	Mean number of sextants	% of population	Mean number of sextants	% of population	Mean number of sextants	% of population	Mean number of sextants
Healthy	5.98	1.23	3.39	1.76	15.42	3.10	0.00	0.67
Bleeding	5.57	5.75	20.34	5.00	55.00	3.00	12.37	5.12
Calculus	18.94	4.97	47.46	3.66	27.08	0.76	60.85	3.74
Pockets 1	58.35	2.36	27.12	0.55	2.50	0.29	26.26	0.53
Pockets 2	11.14	0.29	1.68	0.02	0.00	0.00	0.51	0.02
Edent	0.02	0.54	0.01	0.46	0.00	0.02	0.01	0.05
T1	94.01		96.61		84.58		100.00	
T2	88.44		76.27		29.58		87.62	
T3	11.14		1.69		0		0.51	

Table 2.3: The prevalence, severity and treatment needs of periodontal disease in the four main population groups of the SADF (Rossouw, 1989, Unpublished)

The oral health status of the clientele was described according to the caries and periodontal disease status. It is concluded that there is an extensive curative backlog, especially because of the prevalence of dental caries. The need for prevention and increased operational performance is clearly indicated. Having described the oral health status of the population, the needs and the demands of the clientele regarding oral health care are deliberated next.

2.4.1.3. Needs and demands

According to Van Rensburg *et al* (1992, p 11) the term oral health need includes the *need* for oral health care and *demand* for oral health care. The need for oral health care is defined as being determined by professionals on the basis of objective criteria. The oral health needs of the SADF population was described under oral health status in paragraph 2.4.1.2. The demand for oral health is defined by Van Rensburg *et al* (1992, p 11) as the needs experienced or defined by the clientele itself. The demand of the SADF population can be indicated by a question from the 1987/88 survey.

Why did you visit the dentist the last time?
(Question 13. (Rossouw, 1989, Unpublished))

Demand indicator	Number	%
To clean teeth	88	6.83
To relief pain/emergency	281	21.82
Fillings	349	27.10
Check-up	381	29.57
Re-call by dentist	13	1.01
Referred and treated by specialist	40	3.11
Can't remember	16	1.24
Bleeding gums	7	0.54
Denture	107	8.31
Not applicable	6	0.47
TOTAL	1288	100.00

The difference between the need and demand of the SADF clientele is clearly indicated by Figure 2.23, indicating the need for oral health promotion and education.

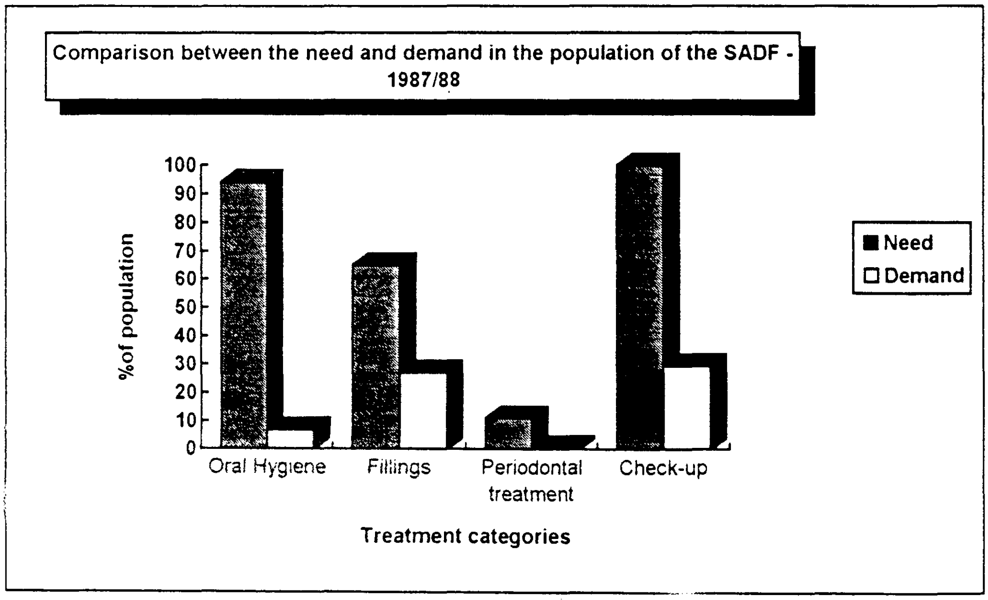

Figure 2.23: A comparison between the needs for oral health care and the demands for oral health care in the clientele of the SAMS (Rossouw, 1989, Unpublished).

2.4.1.4. Oral health culture

Health culture is an umbrella or composite term that includes all those concepts, attitudes, perceptions, beliefs, knowledge and skills, values and customs which the population share in respect of health, disease and care (Van Rensburg *et al*, 1992, p 12). The clientele's health culture obviously harbours important implications for both its health status and its health/illness/consumer behaviour, as well as for the nature and organization of the health care system serving the clientele (Van Rensburg *et al*, 1992, p 13). The important issues concerning oral health culture are the knowledge component of the clientele, their health beliefs and the attitude of the population. The aspects are discussed next.

2.4.1.4.1. Knowledge component

The knowledge component of the health culture refers to what the clientele knows about health, disease and care (Van Rensburg *et al*, 1992, p 14). The population of the SADF responded as follows on questions in an oral health questionnaire.

Do you know that oral problems can develop without you being aware of it or having any pain?
(Question 31 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
No	518	53.46
Yes	451	46.54
TOTAL	969	100.00

Do you know that smoking is detrimental to your oral health?
Question 35 (Rossouw, 1989, Unpublished)

Knowledge indicator	Number	%
No	121	11.36
Yes	944	88.64
TOTAL	1065	100.00

It is better to prevent than to wait and cure?
(Question 39 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
Absolutely positive	867	81.41
Positive	168	15.77
Neutral	7	0.66
Negative	4	0.38
Absolutely negative	19	1.78
TOTAL	1065	100.00

False teeth are just as good as natural teeth.
(Question 40 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
Absolutely positive	829	77.84
Positive	106	9.95
Neutral	71	6.67
Negative	19	1.78
Absolutely negative	40	3.76
TOTAL	1065	100.00

Teeth should be extracted when they give problems.
(Question 41 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
Absolutely positive	625	58.74
Positive	182	17.11
Neutral	115	10.81
Negative	68	6.39
Absolutely negative	74	6.95
TOTAL	1064	100.00

Do you know how dental caries develops?
(Question 54 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
No	850	80.04
Yes	212	19.96
TOTAL	1062	100.00

Do you know how gum disease develops?
(Question 55 (Rossouw, 1989, Unpublished))

Knowledge indicator	Number	%
No	879	82.85
Yes	182	17.15
TOTAL	1061	100.00

These questions indicate that the clientele of the SAMS knows something about health in general (88% are against smoking, and 82% are positive about prevention), but their knowledge about oral health and dentistry is actually very low. This indicates the urgent need for prevention and oral health promotion.

2.4.1.4.2. Health beliefs

This reflects what people think and believe regarding health, disease and care (Van Rensburg *et al*, 1992, p 14). The population of the SADF responded as follows on the questionnaire of the 1987 survey.

2.4.1.4.2.1. Regarding the origin of disease the following:

Food is an important factor in the development of dental caries.
(Question 45 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
Absolutely positive	738	69.30
Positive	220	20.66
Neutral	53	4.98
Negative	32	3.00
Absolutely negative	22	2.07
TOTAL	1065	100.00

Bacteria cause tooth decay and gum disease.
(Question 46 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
Absolutely positive	797	74.98
Positive	204	19.19
Neutral	42	3.95
Negative	6	0.56
Absolutely negative	14	1.32
TOTAL	1063	100.00

These answers indicate that the clientele tend to believe that food and bacteria are important aetiological factors, but from the knowledge indicators it is clear that they do not know the consequences of disease.

2.4.1.4.2.2. Regarding the providers of care and the diagnosis of disease:

You should visit the dentist only when you experience pain.

(Question 38 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
Absolutely positive	50	4.69
Positive	46	4.32
Neutral	32	3.00
Negative	101	9.47
Absolutely negative	837	78.52
TOTAL	1066	100.00

Do you believe that you need the dentist to keep your teeth as long as possible?

(Question 65 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
No	54	5.08
Yes	1009	94.92
TOTAL	1063	100.00

Dentists are inclined to make money rather than caring for their patients.

(Question 51 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
Absolutely positive	115	10.80
Positive	143	13.43
Neutral	274	25.73
Negative	180	16.90
Absolutely negative	353	33.15
TOTAL	1065	100.00

Oral hygienists deliver an essential service.

(Question 50 (Rossouw, 1989, Unpublished))

Belief indicator	Number	%
Absolutely positive	684	64.17
Positive	137	12.85
Neutral	232	21.76
Negative	4	0.38
Absolutely negative	9	0.84
TOTAL	1066	100.00

These questions indicate that the clientele of the SAMS probably trust the dentist as a provider of dental care. Although they do believe in prevention the oral hygienist is not seen as playing an important role, indicating the need to promote their role.

2.4.1.4.3. Attitudes

The attitude of the clientele refers to what people feel and experience regarding health, disease and care (Van Rensburg *et al,* 1992, p 14). The 1987/88 survey indicated the following response on relevant questions.

Why don't you visit the dentist regularly?
(Question 8 (Rossouw, 1989, Unpublished))

Attitude indicator	Number	%
Fear the dentist	28	2.64
Don't like the dentist	16	1.51
Dental personnel is unfriendly	24	2.26
TOTAL	1062	100.00

How do you feel when you know you have to visit the dentist the following day?
(Question 21 (Rossouw, 1989, Unpublished))

Attitude indicator	Number	%
Looking forward	54	5.06
A bit nervous	244	22.87
Fear the appointment	79	7.40
Do not mind	690	64.67
TOTAL	1067	100.00

How do you feel when waiting for your appointment in the waiting room?
(Question 22 (Rossouw, 1989, Unpublished))

Attitude indicator	Number	%
Relaxed	590	55.50
Nervous	313	29.44
Tense	120	11.29
Anxious	40	3.76
TOTAL	1063	100.00

It is concluded from the answers that the clientele do not fear or dislike the dentist. There is however a large proportion of the clientele feeling anxious or nervous about appointments. It can thus be argued that patients do not like the procedures involved with dental treatment. They could probably prefer health and health related procedures.

According to Van Rensburg *et al* (1992, p 14) knowledge, beliefs and attitudes in respect of health, disease and care (health culture) of the population are the precedents and indeed the direct determinants of the health behaviour, illness behaviour and consumption behaviour of that population.

Regarding the oral health culture of the clientele the following conclusions:

- The knowledge of the population regarding oral health and dentistry is low to very low - indicating the need for oral health promotion.
- The clientele probably know the aetiological factors of dental disease, but they do not know the consequences of disease, thus leaving them with a lack of motivation to apply their knowledge concerning the aetiology.
- Although the clientele believe in prevention they only trust the dentist (secondary and tertiary care) and not the oral hygienist (primary care oriented) - indicating the need to promote the oral hygiene profession.
- The clientele dislike dental treatment procedures, they will probably be satisfied with less dramatic, painless preventive procedures.

The oral health behaviour of the clientele is discussed next.

2.4.1.5. Oral health behaviour (Health, illness and consumption behaviour)

The behaviour of the clientele with regard to health, illness and consumption is directly linked to its health culture. What people know, think, believe and feel regarding health, disease and care is translated into actual behaviour or modes of action (Van Rensburg *et al,* 1992, p 14). The oral health behaviour of the population is discussed under the headings health and illness behaviour and consumption behaviour.

2.4.1.5.1. Health and illness behaviour

According to Van Rensburg *et al* (1992, p 14) health behaviour comprises activities undertaken by people with the intention of maintaining their health and/or preventing disease or detecting it at an asymptomatic stage. Health behaviour thus refers to all health-maintaining, health-promoting and disease-preventing actions of the clientele. Van Rensburg *et al* (1992, p 15) describes illness behaviour as those actions and activities concerned with, and as a result of, specific disease conditions and symptoms. Van Rensburg *et al* (1992, p 14) classifies illness behaviour as health-risking, health-destroying and disease promoting actions in which the clientele is engaged, and the actions of the population when it is confronted by disease and symptoms.

The population of the SADF responded to a questionnaire as follows:

2.4.1.5.1.1. Regarding regular check-ups.

Did you or your family use the Oral Health Service of the SAMS during the preceding twelve months?

(Question 5 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
No	276	25.89
Yes	790	74.11
TOTAL	1066	100.00

Do you and your family use the Oral Health Service of the SAMS frequently as a habit of good health?

(Question 14 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
No	425	39.98
Yes	638	60.02
TOTAL	1063	100.00

Do you have the intention to visit the dentist or oral hygienist in the near future?
(Question 30 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
No	473	44.75
Yes	584	55.25
TOTAL	1057	100.00

These questions clearly indicate that the dentist is only visited if necessary for dental problems or pain.

2.4.1.5.1.2. Regarding the influence of illness on behaviour.
How did dental problems influence you in the past?
(Question 17 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
Appointment during working hours	275	25.94
Could not sleep/pain	209	19.71
Absenteeism	62	5.84
Other	514	48.51
TOTAL	1060	100.00

The response to this question indicates that 52 percent of the population's behaviour is drastically interrupted by dental problems.

2.4.1.5.1.3. Regarding smoking habits
Do you smoke?
(Question 36 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
No	587	55.59
Yes	469	44.41
TOTAL	1056	100.00

Although 89 percent of the clientele believes that smoking is bad for health, only 55 percent is not smoking - indicating again that the consequences of disease are not acknowledged.

2.4.1.5.1.4. Regarding oral hygiene habits

How many times a day do you brush your teeth?
(Question 58 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
Never	8	0.75
Once	213	20.06
Twice	736	69.30
Three times	89	8.38
Four and more	16	1.51
TOTAL	1062	100.00

Why do you brush your teeth?
(Question 60 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
To prevent decay	732	68.99
To prevent gum disease	30	2.83
Fresh breath	142	13.38
Other	157	14.80
TOTAL	1061	100.00

How many times a day do you use dental floss?
(Question 63 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
Never	836	78.65
Once	190	17.87
Twice	37	3.48
TOTAL	1063	100.00

Do you use a fluoride mouth rinse?
(Question 67 (Rossouw, 1989, Unpublished))

Behaviour indicator	Number	%
No	837	78.96
Yes	223	21.04
TOTAL	1060	100.00

These questions indicate that the oral hygiene habits of the clientele are on a relatively high level. This is probably not because they want to prevent disease, but because they want to be socially acceptable.

Regarding the health and illness behaviour of the clientele the following conclusions:

- The clientele predominantly visit the dentist when having dental problems or pain.
- Dental problems disturb the normal behaviour of the clientele.
- Although the populations know that smoking is detrimental to oral health they do smoke - probably due to a lack of knowledge regarding the consequences.
- The relatively high level of oral hygiene habits is probably due to a need for social acceptance.

2.4.1.5.2. Consumption behaviour (Utilization and service statistics)

The utilization of dental services is described by using the service statistics of the different military dental clinics providing a dental service to the population of the SADF. (The dental service *per se* is described under micro level indicators)

There were 146 753 dental contacts (patient visits to a dentist) in 1989 and the total amount of clinical work done during these contacts, according to the National Schedule of Fees, was R 7 093 737,00 (Rossouw, 1990, Unpublished). This indicates an average cost of R48,34 per contact.

Dividing the dental contacts into categories of diagnostic procedures, preventive procedures, restorations, prosthodontic procedures, endodontic procedures, extractions and minor oral surgery, prosthetic procedures, and periodontal procedures indicates the lack in prevention and the growing need for costly secondary and tertiary services. Figure

2.24 illustrates the proportional distribution of the mentioned categories.

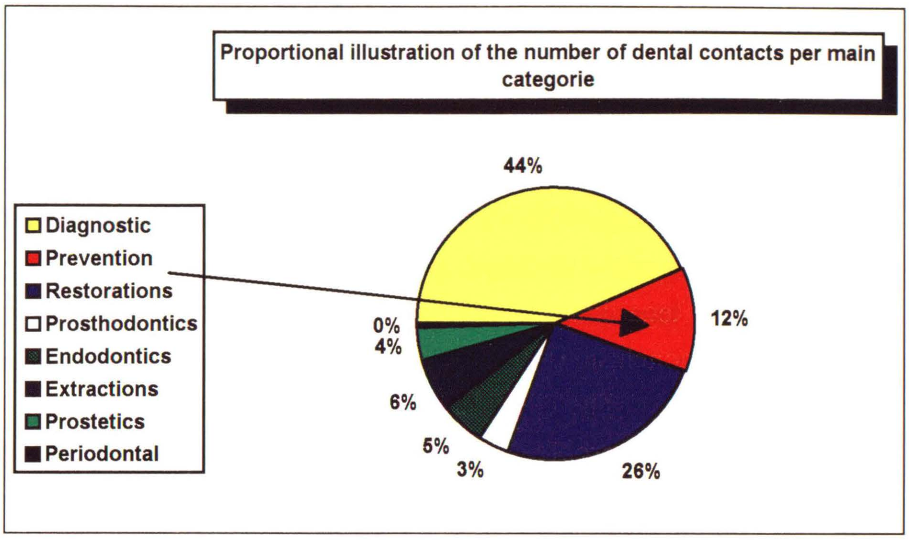

Figure 2.24: An illustration of the proportional relation between the main categories of dental treatments in the Oral Health Service of the SAMS for 1989 according to the number of contacts per category (Rossouw, 1990, Unpublished).

It is concluded that the health and illness behaviour of the clientele, and the utilization of services are mainly based on costly secondary and tertiary care. A comparison between consumption, need and demand is illustrated in Figure 2.25. It is concluded that there is a vast difference between need, demand and utilization indicating the need for oral health promotion and prevention.

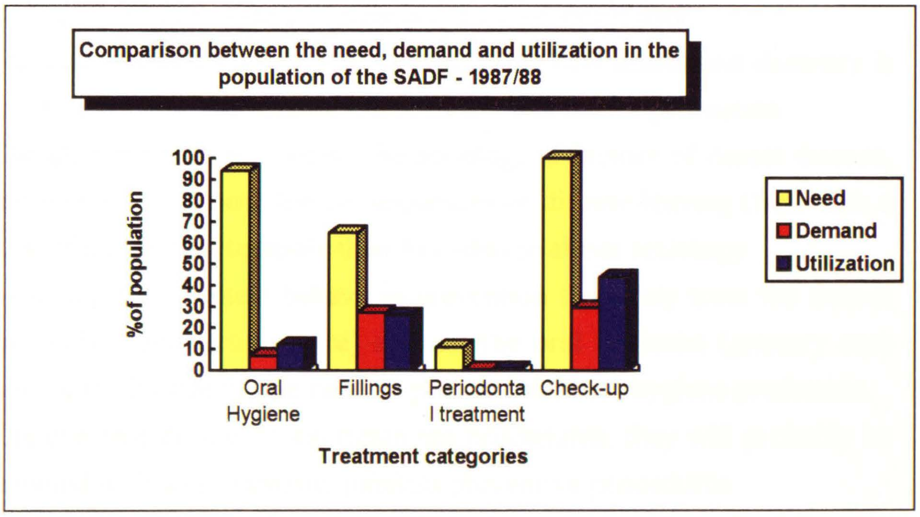

Figure 2.25: A comparison between the needs and the demands for oral health care as well as the utilization in the clientele of the SAMS (Rossouw, 1989, Unpublished).

Fluoridation is finally deliberated as a meso-level indicator.

2.4.2. Water fluoridation

The population of the SADF is geographically distributed throughout South Africa as described in paragraph 2.4.1.1. and mainly uses municipal water. Furthermore, the migration of the population due to annual/regular transferrals of SADF members between units, contributes to the impossibility of using the fluoride contents of drinking water as a distinct discriminating indicator in oral health planning. The dental personnel of the SAMS, however, prescribe the optimal use of fluorides in the relevant regions. Furthermore the population of the SADF is a tooth-brushing population, making water fluoridation less urgent.

The meso-level indicators of the Oral Health Service of the SAMS were discussed regarding the clientele and water fluoridation. The following conclusions are noted:

⇨ The majority of the clientele are demographically defined as: Uniformed; Army; male; age 35-44, stay in Pretoria; and Caucasian at this stage, and secondly the children of these members.

⇨ There is an extensive curative backlog in the clientele. The need for prevention and increased operational performance is indicated.

⇨ There is a vast difference between needs on the one hand and demands and utilization on the other hand - indicating the need for health promotion and education.

⇨ The oral health culture of the clientele is described as follows:
- The knowledge of the population regarding oral health and dentistry is low to very low - indicating the need for oral health promotion.
- The clientele probably know the aetiological factors of dental disease, but they do not know the consequences of disease leaving them with a lack of motivation to apply their knowledge about aetiology.
- Although the clientele believe in prevention they only trust the dentist (secondary and tertiary care) and not the oral hygienist (primary care oriented) - indicating the need to promote the oral hygiene profession.
- The clientele dislike dental treatment procedures; they will probably be satisfied with less dramatic, painless preventive procedures.

⇨ Regarding the health and illness behaviour of the population the following are important:

- The clientele predominantly visit the dentist when they have dental problems or pain.
- Dental problems disturb the normal behaviour of the clientele.
- Although the population know that smoking is detrimental to oral health they do smoke - probably due to a lack of knowledge regarding the consequences.
- The relatively high level of oral hygiene habits is probably due to a need for social acceptance.

⇨ Regarding water fluoridation it is concluded that due to the fact that 99 percent of the clientele regularly brush their teeth, water fluoridation is not an important issue.

The final assessment of the situation is on the micro level.

2.5. Indicators on the micro level

Micro level indicators are discussed under the headings: Organization; Organizational functional management; and Organizational dispensation on resources.

2.5.1. Organization

The structure, mission and aim of the Oral Health Service of the SAMS is deliberated as part of the organization.

2.5.1.1. Structure

The organizational structure of the Oral Health Service of the SAMS is based upon the organizational structure of the SAMS. There are basically four organizational levels (Figure 2.26).

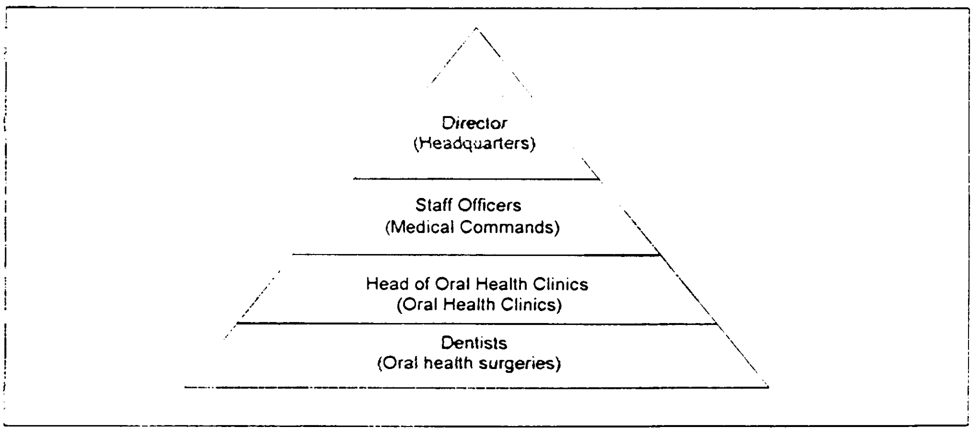

Figure 2.26: The organizational hierarchy of the Oral Health Services of the SAMS.

The service rendering performance or output areas of the Dental Service are broadly classified as *internal* and *external*. The internal performance area is subdivided into the three main components of the simplified oral health system, namely the patient (community), the dental team and the delivery sub-system (Figure 2.27). Each one of these sub-systems is described as documented in the Doctrine of the Oral Health Service, SAMS, 1990.

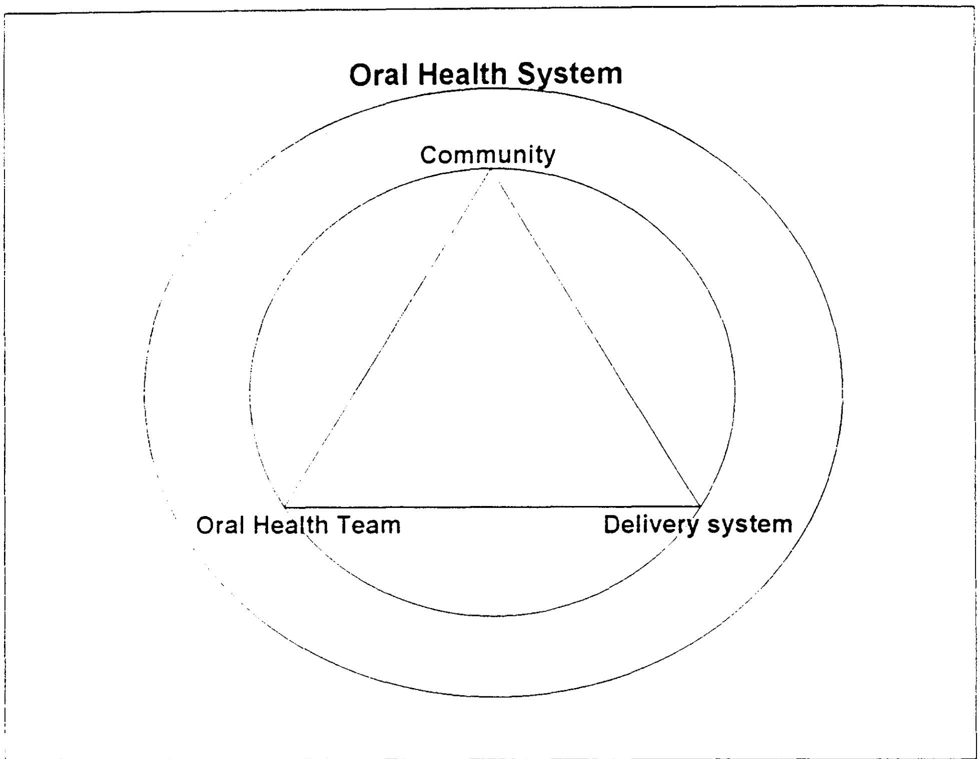

Figure 2.27: The oral health system of the SAMS with its three subsystems or performance areas.

2.5.1.1.1. The patient (community)

This sub-system symbolizes the total clientele of the Oral Health Service of the SAMS. It includes the disease profile and appropriate strategies to deal with disease.

2.5.1.1.2. The oral health team

The dental team consists of dental specialists, dentists, oral h
dental technicians, dental assistants and other supporting staff. The proportional number and use of the different team members are briefly discussed.

2.5.1.1.2.1. Dental specialists

A minimum of full-time specialists (one or two per discipline) form the core of the tertiary care level. These specialists are co-responsible for the policy regarding their speciality. Community Dentist specialists are used at the Headquarters for oral health information - and service operation management.

2.5.1.1.2.2. Dentists

Dentists are the core of the oral health service. They deliver mainly secondary care in military dental clinics situated throughout South Africa. The Director Oral Health strives for a dentist:population ratio of approximately 1:2300.

2.5.1.1.2.3. Oral hygienists

The main function of oral hygienists is to be involved in oral health promotion and prevention in the community, and their secondary function is to be available for clinic-based preventive procedures.

2.5.1.1.2.4. Dental technicians

Dental technicians are based at the larger dental clinics, but also provide the smaller clinics with dental laboratory services where possible. The ideal dental technician:dentists ratio is 1:4.

2.5.1.1.2.5. Dental assistants

Dental assistants support dentists and specialists in their function.

2.5.1.1.2.6. Administrative staff

Dental clinics are provided with one or more receptionists, depending on the size. They are responsible for patient administration, general administration and capturing of data on the mainframe computer system.

2.5.1.1.3. The delivery sub-system

The following aspects are identified as part of the delivery sub-system, namely (1) The dental service *per se*, (2) Logistics and financing, (3) Public relations, and (4) Management information system.

It is concluded that the Oral Health Service of the SAMS has a formal organizational structure, with four level vertical dimensions making communication, the decision process and policy implementation extremely difficult. The situation is worsened by the fact that Staff Officers Oral Health at medical commands are actually serving two bosses, the one being their functional (professional) head (Director Oral Health), and the other being the Officers Commanding the specific medical command.

Concerning the components of the simplified oral health system it is concluded that although the model is elementary it seems to be comprehensive and effective. Some more external orientation could however help the system to be more competitive and strategically aligned.

Concerning the oral health team the lack of dentists and especially oral hygienists is probably one of the greatest problem. . . Oral Health Service of the SAMS.

2.5.1.2. The mission of the Oral Health Service of the SAMS

The oral health team constructed their own mission statement and core mission.

2.5.1.2.1. The mission statement

"We are a dynamic team who strives to achieve optimal oral health, patient satisfaction and self care for all our patients.

The aim of the dental service of the South African Medical Service is the rendering of a timely, comprehensive dental service to all the patients entitled to it. The service comprises of an operational as well as a base oriented preventive, curative, rehabilitative and promotive service. Primary prevention is a priority.

We commit ourselves to:

- ⇨ *high scientific and clinical standards*
- ⇨ *a professional attitude towards our patients regardless of their seniority, colour, religion, and gender*
- ⇨ *applied research to benefit our patients and our organization*
- ⇨ *effe... management of our service to ensure efficiency"*

2.5.1.2.2. The core mission

"To conquer tooth and mouth disease in co-operation with our patients."

It is concluded that both the mission statement and core mission of the Oral Health Service of the SAMS are strategically aligned. It is however noted that although both the core mission and the mission statement are concerned with primary prevention as a priority, there seems to be a lack of commitment to the mission at operational level.

2.5.1.3. The aim of the Oral health service of the SAMS

The aim of the Oral health service of the SAMS is accomplished by the objectives of the three main sub-systems, as discussed above. For the purpose of this document only the objective concerning oral health is described.

2.5.1.3.1. Objective 1: Oral health

To ensure dental functionality of our patients and an optimum level of self care.

2.5.1.3.1.1. Sub-objective 1.1

To ensure a preventive oral health service.

2.5.1.3.1.2. Sub-objective 1.2

To ensure a restorative and rehabilitative oral health service.

2.5.1.3.1.3. Sub-objective 1.3

To ensure a promotive oral health service.

From the discussion on the structure, mission and aim of the Oral Health Service of the SAMS it is concluded that the issues hindering the implementation of top management's vision at the operational level, are probably the organizational structure and the lack of commitment to the mission.

2.5.2. Organizational functional management

The SAMS is a typical complex line-staff organization. The management of the different services (or products) involved in comprehensive health care are managed by directorates in the different disciplines. Supporting services are managed by the appropriate staff functions, namely personnel, logistics and finance. The organizational format of the SAMS mainly leads to the following disadvantages (Kerzner, 1992, p 110):

- Co-ordination is complex and additional time is required for approval of decisions.
- Response to patient needs is slow.
- There is difficulty in pinpointing responsibility.
- Motivation and innovation are suppressed.
- Ideas tend to be functionally oriented.

This short discussion on the complex functional management of the SAMS supports the notion that organizational structure limits strategic implementation.

2.5.3. Organizational dispensation on resources

Only the manpower situation within the Oral Health Service of the SAMS is discussed.

2.5.3.1. Manpower situation

The SAMS is currently inadequately staffed. Although the present personnel situation cannot cope with the curative backlog and demand, the main concern is the shortage in preventive personnel (like oral hygienists) and the lack in preventive care by dentists as described under utilization.

The core of the personnel, dentists, who have been trained according to a predominantly curative model on pre-graduate level are confronted by a backlog of curative demand. An open-ended questionnaire from regional dental staff officers indicated the resistance to implement preventive strategies and programmes in the light of the curative backlog.

The organization, the functional management and the dispensation on manpower as micro-level indicators have been discussed. It is concluded that the organizational structure and functional management, the culture of personnel (lack of commitment to the mission and curative paradigm) and the lack of oral hygienists are probably the main obstacles in the way of a strategic strategy implementation.

Having scanned the global trends, and the macro-, meso- and micro-level indicators to gather information regarding the situation in the Oral Health Service of the SAMS, the next step in the SSM of Checkland is to express the problem situation as concisely but also as comprehensively as possible.

3. The problem situation expressed

The global trends, as deliberated earlier, that will possibly influence the Oral Health Service of the SAMS indicate that: The Oral Health Service of the SAMS will have to do more better to stay competitive; Due to the decline in the importance of the military, the Oral Health Service of the SAMS will have to be more efficient; The change in the SADF population may cause an increase in the disease profile of the clientele; The POHC approach will have to be applied in order to make the service more affordable, accessible, acceptable and appropriate.

Concerning the national economy of South Africa an increase in state intervention could mean that health care resources would be redistributed on a national level - indicating that the budget of the SAMS and its ability to render a treatment service would decrease.

The macro-level indicators suggest that: The prevailing economic situation will force the SAMS to deliver approximately the same output with a vast decline in resources; The political issues will further burden national resources and a redistribution of the available "health care cake" will definitely leave the SAMS in an inferior situation to the present; There is however technology available on the primary care level that can help the SAMS to make oral health care more affordable; The changes in the population of the SADF will force the SAMS to change its "developed population care" paradigm.

The meso-level indicators denote the following for the Oral Health Service of the SAMS: The bulk of the clientele are demographically defined as: Uniformed; Army; male; age 35-44, stay in Pretoria; and Caucasian at this stage; There is an extensive curative backlog in the clientele, which stresses the need for prevention and increased operational performance; There is a vast difference between needs on the one hand and demands and utilization on the other hand - indicating the need for health promotion and education; The oral health culture of the clientele is described as follows:

- ⇨ The knowledge of the population regarding oral health and dentistry is low to very low - indicating the need for oral health promotion.
- ⇨ The clientele probably know the aetiological factors of dental disease, but they do not know the consequences of disease leaving them with a lack of motivation to apply their knowledge about aetiology.

- ⇨ Although the clientele believe in prevention they only trust the dentist (secondary and tertiary care) and not the oral hygienist (primary care oriented) - indicating the need to promote the oral hygiene profession.
- ⇨ The clientele dislike dental treatment procedures; they will probably be satisfied with less dramatic, painless preventive procedures.

Regarding the health and illness behaviour of the population the following is important:

- ⇨ The clientele predominantly visit the dentist when they have dental problems or pain.
- ⇨ Dental problems disrupt the normal behaviour of the clientele.
- ⇨ Although the population know that smoking is detrimental to oral health they do smoke - probably due to a lack of knowledge regarding the consequences.
- ⇨ The relatively high level of oral hygiene habits is probably due to a need for social acceptance.

And finally regarding water fluoridation it is concluded that due to the fact that 99 percent of the clientele regularly brush their teeth, water fluoridation is not an important issue.

On a micro level it is concluded that the Director Oral Health of the SAMS and his team have a vision for oral health in the population of the SADF. This vision for oral health and oral health care is broadly stated in a mission statement which clearly indicates top management's commitment to prevention of disease and promotion of oral health.

This mission statement is however not operationalized by the rest of the dental team. The reason for this lack in health promoting and preventive services is presumably multi-dimensional and depends on: [1] The situation and perception towards oral health and oral health care of the person (dental team and clientele) involved; [2] The organizational structure and functional management; [3] The dental care culture (curatively oriented); and [4] The lack of preventive oriented oral hygienists. The view of dentists is influenced by the predominantly curatively oriented pre-graduate training and the curative backlog and demand for essential care. The dental staff officers of the different medical commands are probably positioned somewhere in between the mission statement of the Director Dentistry and the perception of the operating dentists. Their position possibly depends on their knowledge, their insight into oral health care and their ability to make long term projections. They are furthermore not convinced that prevention will reduce future curative demand. The bottom line is summarized by a question such as: "What is wrong with a filling, a crown, a denture?"

The oral health status of the population indicates the urgent need for preventive dental services. The beliefs of the clientele are also more preventively oriented. The services the clientele receive as a response to their oral health culture, are however, primarily based on secondary and tertiary levels of care. This probably influences their satisfaction of care received.

The curative backlog forces the dental service to refer patients to the fee-for-service private sector, which causes a loss of a managed oral health care opportunity and escalating costs.

Concurrently with the declining military budget (military health care), demand for equal health care and political transition in South Africa, and all the factors mentioned above which lead to a rise in treatment cost, it is realized that the present mode of rendering the service will have to be redirected.

From this deliberation the next step in Checkland's SSM is to present a rich picture of the situation.

4. The rich picture of the problem situation

Figure 2.28 is a rich picture of the problem situation. Alternatives are possible but the main issues will remain the same as described in paragraph 3 above.

5. Relevant systems

According to Flood and Jackson (1991, p 174) a number of themes surface from the rich picture which can be captured as a set of relevant viewpoints, or "relevant systems". Flood and Jackson (1991, p 174) state that this part of the SSM is effectively linking the two modes of thought, namely systems thinking and "real world" thinking.

From the "real world" problem situation in the Oral Health Service of the SAMS the following relevant systems were identified:

1. Oral health delivery system
2. Preventive system or project
3. Performance measurement system
4. Management system
5. Organizational system
6. Oral health team
7. Supporting system

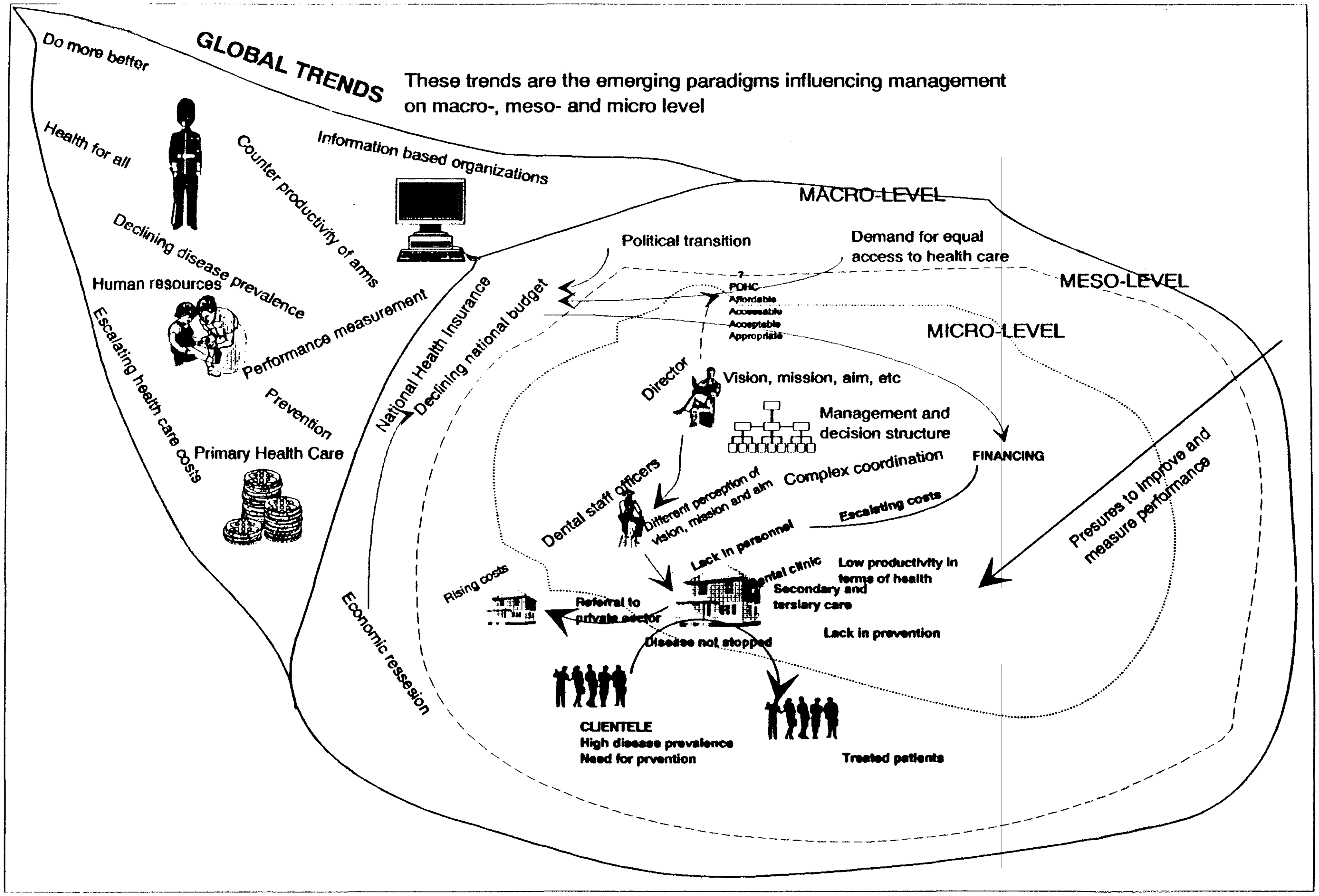

Figure 2.28: SSM "Rich Picture" of the situation in the Oral Health Service of the SAMS.

The oral health delivery system and a performance measurement system were identified as the two important systems to enhance the final output of the total system. These two relevant systems are explored in more depth in chapter 3.

6. Summary

In this chapter the situation in the Oral Health Service of the SAMS was examined by the use of a business economics environmental scanning process. From this information the problem situation was expressed in concise but comprehensive format. A rich picture was presented from the information gathered and finally relevant systems were identified.

Chapter 3 considers the development of the relevant systems.

CHAPTER 3

DEVELOPMENT OF THE RELEVANT SYSTEMS

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CHAPTER 3

DEVELOPMENT OF THE RELEVANT SYSTEMS

1. Introduction

In Chapter 2 the situation in the Oral Health Service of the SAMS was assessed. The problem was expressed concisely and comprehensively, whereafter a "Rich Picture" of the situation was presented and relevant systems were identified. This chapter deals with the development of the relevant systems according to the Soft Systems Methodology of Checkland. The two relevant systems selected in Chapter 2, namely the preventive system and the performance measurement system are further developed by firstly developing a root definition and conceptual model, whereafter the real world situation and the conceptual model are compared. Finally feasible and desirable changes for every system are defined. Firstly, the Preventive System is described as it developed through stages 3 to 6, where after the Performance Measurement System is presented in the same way. (For a complete discussion on the Soft Systems Methodology see Appendix A.)

The framework of Chapter 3 and its orientation within the dissertation is presented in Figure 3.1.

2. Preventive System

The Preventive System identified in Chapter 2 is developed through the following steps: [1] The root definition of the Preventive System; [2] The conceptual model for the system; [3] The comparison between the real world situation and the conceptual model; and [4] The definition of feasible, desirable change.

2.1. Root definition of the Preventive System

Stage 3 of Checkland's SSM is concerned with expanding each relevant system, identified during stage 1 (The problem situation unstructured) and stage 2 (The problem expressed), into concise well-formulated verbal statements - root definitions (Flood and Jackson, 1991, p 175). A root definition is an idealized view of what a relevant system should be. This is accomplished by formulating the root definition around six elements - also known as the CATWOE mnemonic or analysis.

The root definition of the Preventive System was defined by using this CATWOE analysis. The *Weltanschauung* and transformation were considered first.

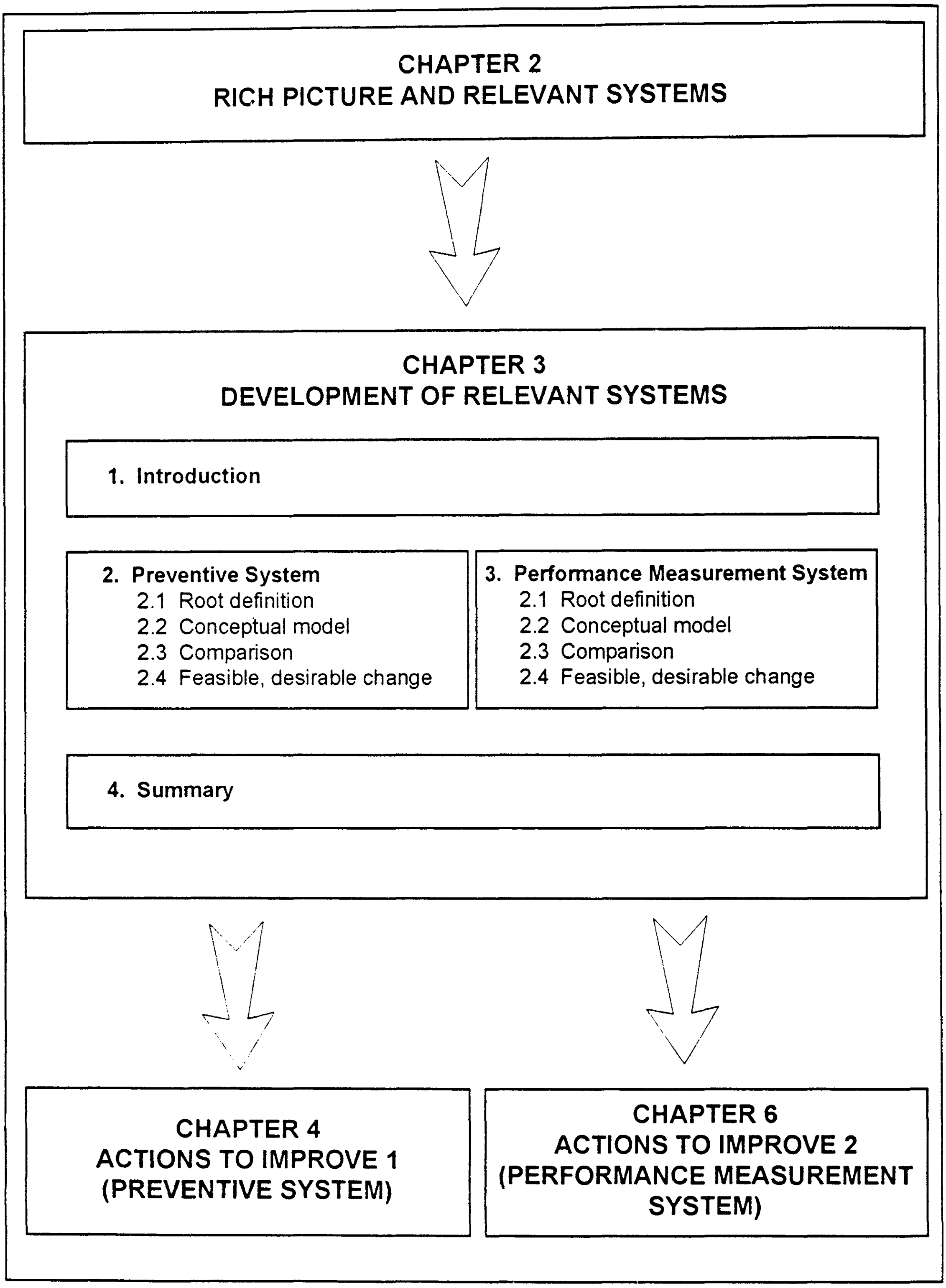

Figure 3.1: Conceptual framework of Chapter 3 and its orientation within the dissertation

Customers	Patient population of the SADF
Actors	Dental team delivering an affordable, accessible, available and acceptable oral health service
Transformation	Potential oral health into actual oral health
Weltanschauung	Prevention can conserve oral health
Owners	SAMS top management and politicians
Environmental constraints	Attitude of dental officers to oral health, and support from dental staff officers regarding personnel, logistics, etc.

The root definition of the Preventive System was finally formulated as:

> The Oral Health Service of the SAMS is a public institution aiming to transform potential oral health of the SADF population into actual oral health through a dental team delivering an affordable, accessible, available and acceptable oral health service, so that all parties concerned will benefit.

After the root definition of the Preventive System was formulated the next step was to construct the conceptual model for the system.

2.2. Conceptual model of the Preventive System

Stage 4 (building a conceptual model) of Checkland's SSM is a description of the activities the ideal system must do in order to fulfil the requirements of the root definition (Flood and Jackson, 1991, p 176). The conceptual model is constructed by using the minimum number of verbs required to describe the activities that would have to be present in order to carry out the task described in the root definition. These verbs are logically arranged according to how they depend on each other and how they would work together in the real system.

The following verbs were identified as essential in the primary actions of the Preventive System:

1. Select target populations
2. Establish accessibility
3. Identify risk
4. Prevent disease

5. Cure disease
6. Promote oral health
7. Monitor and control

From these verbs the conceptual model in Figure 3.2 was constructed.

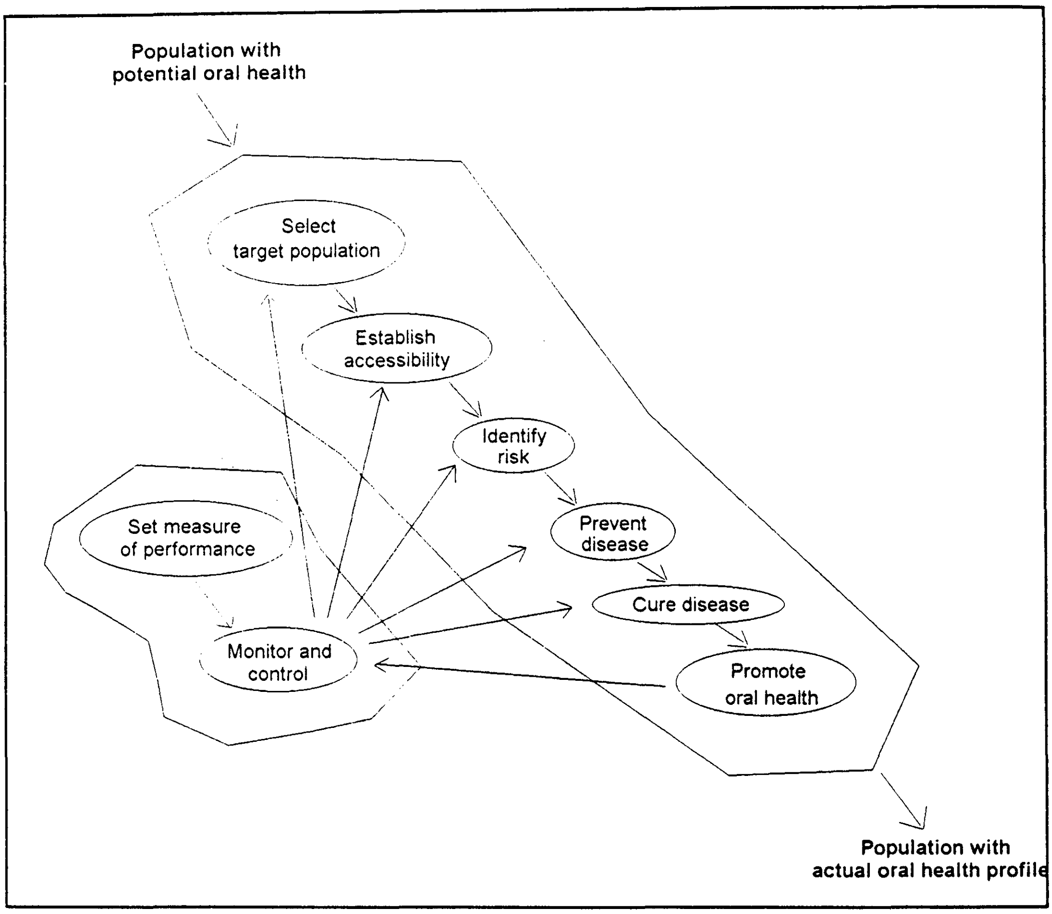

Figure 3.2: A conceptual model for the Preventive System of the Oral Health Service of the South African Medical Service

Having established the ideal conceptual model the following step was to compare it with the real world situation.

2.3. Comparison between the real world situation and the conceptual model

The aim behind the comparison stage is to generate possible changes that could improve the real world situation.

The conceptual model was compared to the real world situation using Table 3.1.

Activity	Present in real world	Comment	Include in solution
1. Select target population	No	The present situation does not select target populations. Patients visiting dental clinics are part of the oral health or illness behaviour of the population.	Yes
2. Establish accessibility	?No	The "accessibility" of the present oral health service is mainly determined by the oral health or illness behaviour of the population. No process is aimed at giving access to the part of the population who really needs the service.	Yes
3. Identify risk	No	No process exists to identify risk in order to deal with the 20:80 principle.	Yes
4. Prevent disease	?No	The prevention of disease by the present system is debatable.	Yes
5. Treat disease	Yes	The present system do treat disease - perhaps even over-treat	Yes
6. Promote oral health	?No	The promotion of oral health by the present system is negligible	Yes
7. Monitor and control	?Yes	There is some kind of control in the present system - but not in terms of oral health objectives	Yes

Table 3.1: A comparison between the conceptual model for the Preventive System of the Oral Health Service of the SAMS and the real world situation.

After the real world situation and the conceptual model were compared, feasible and desirable change could be defined.

2.4. Defining the feasible, desirable change

Stage 5 of Checkland's SSM inevitably involves consideration of possible changes. Flood and Jackson (1991, p 184) describe three types of possible changes, namely attitudinal changes, structural changes and procedural changes.

The following change concerning the Preventive System was suggested by the comparison above which implied attitudinal, structural and procedural changes:

> The implementation and managing of an oral health project that will select target groups, establish accessibility, identify risk, prevent disease, treat disease and promote oral health of the population of the SADF.

The development of the Preventive System was described following the stages proposed by Checkland's SSM. Feasible and desirable change was finally described. The planning, development and implementation of the Preventive System (project) is deliberated in Chapter 4. The second relevant system identified in Chapter 2, namely the Performance Measurement System, is developed next.

3. Performance Measurement System

The development of the Performance Measurement System also followed the steps proposed by Checkland, namely: [1] The root definition of the Preventive System; [2] The conceptual model for the system; [3] The comparison between the real world situation and the conceptual model; and [4] The definition of feasible, desirable change.

3.1. Root definition of the performance measurement system

The root definition of the performance measurement system was also defined by using a CATWOE analysis.

Customers	Population of the SADF
Actors	Dental team
Transformation	Inadequate performance of the dental team regarding oral health care into effective, efficient and quality performance
Weltanschauung	Performance in oral health services equals enhancement of oral health
Owners	SAMS top management, politicians
Environmental constraints	Resistance to change

The root definition of the Performance Measurement System was finally defined as follows:

> The performance measurement system of the SAMS is aiming to transform inadequate performance of the dental team regarding oral health care into effective, efficient and quality performance according to the objectives of the Oral Health Service of the

SAMS through a dental team doing the right thing right, so that all parties involved will benefit.

After the root definition was defined the following step was to construct a conceptual model of the Performance Measurement System.

3.2. Conceptual model of the performance measurement system

The following verbs were identified as essential in the primary actions of the performance measurement system:

1. Set objectives
2. Identify criteria
3. Establish standards
4. Measure performance
5. Monitor and control

From these verbs the conceptual model in Figure 3.3 was constructed.

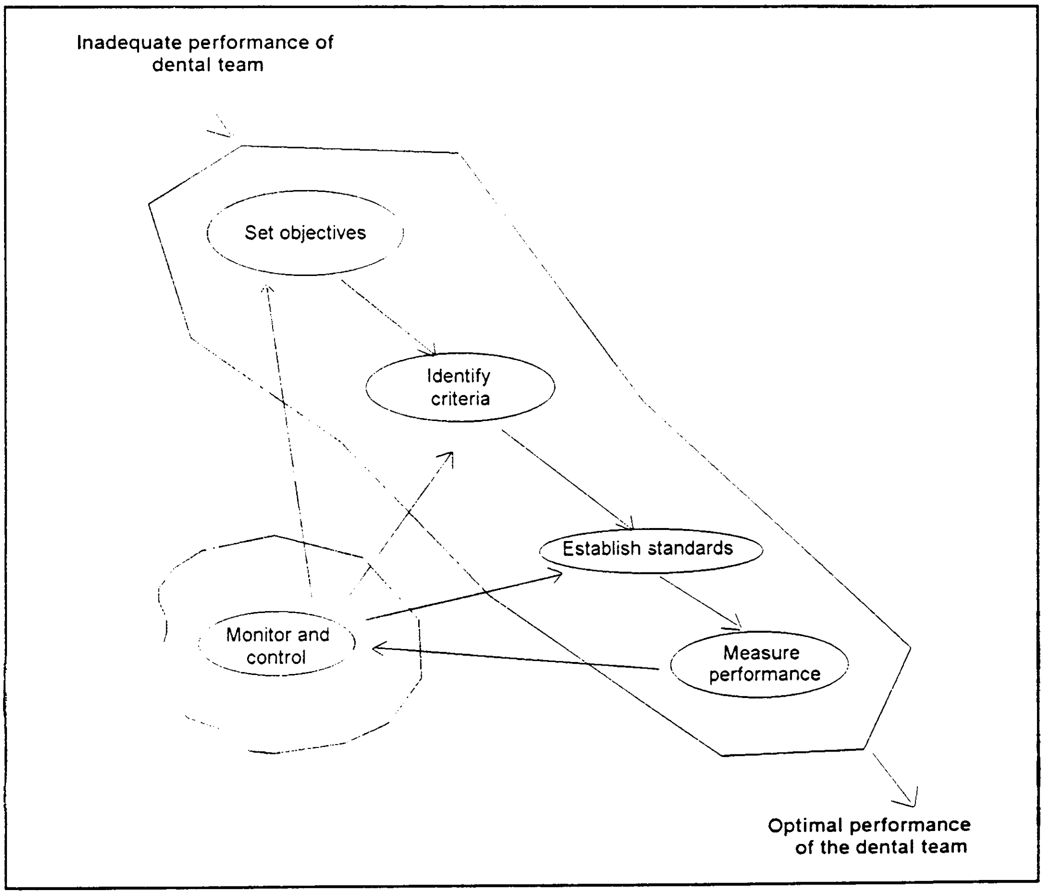

Figure 3.3: A conceptual model for the performance measurement system of the Oral Health Service of the South African Medical Service

The next step was to compare this conceptual model with the real world situation.

3.3. Comparison between the real world situation and the conceptual model

The conceptual model was compared to the real world situation using table 3.2.

Activity	Present in real world	Comment	Include in solution
1. Set objectives	?No	Before 1992 objectives were set in terms of curative output. No oral health objectives were defined.	Yes
2. Identify criteria	?No	Criteria to measure oral health promoting services did not exist	Yes
3. Establish standards	?No	Oral health promoting standards did not exist	Yes
4. Measure performance	?No	Performance were measure by service statistics and not the achievement of objectives	Yes
5. Monitor and control	No		Yes

Table 3.2: A comparison between the conceptual model for the performance measurement system of the Oral Health Service of the SAMS and the real world situation.

3.4. Defining the feasible, desirable change

The following change is suggested by the comparison above, which implies attitudinal, structural and procedural changes:

> The development, implementation and managing of a performance measurement system that will set objectives, identify criteria, establish standards, measure and improve performance in the Oral Health Service of the SAMS.

The Performance Measurement System was developed following the guidelines proposed by Checkland. The planning, development and implementation of the Performance Measurement System is deliberated in Chapter 6.

4. Summary

The development of the relevant systems (Preventive System and Performance Measurement System) was discussed. Feasible and desirable changes were finally defined. The planning and implementation of the two systems are further deliberated in Chapters 4 and 6.

CHAPTER 4

ACTIONS TO IMPROVE THE SITUATION 1 (PLANNING, DEVELOPMENT AND IMPLEMENTATION OF A PREVENTIVE SYSTEM)

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CHAPTER 4

ACTIONS TO IMPROVE THE SITUATION 1 (PLANNING, DEVELOPMENT AND IMPLEMENTATION OF A PREVENTIVE SYSTEM)

1. Introduction

In Chapter 3 the relevant systems were developed. Feasible and desirable change regarding the Preventive System was defined as: The implementation and managing of a Preventive System (Project) that will select target groups, establish accessibility, identify risk, prevent disease, treat disease and promote oral health of the population of the SADF. Chapter 4 deals with the first sub-system identified to improve the situation within the Oral Health Service of the SAMS, namely the Preventive Project. The Preventive Project was planned, developed and implemented according to a framework for project management proposed by Kerzner (1992, p 81) and De Wit and Hamersma, (1992, p 303). A short discussion of this theoretical framework is followed by the conceptual and planning phases, the definition and design phase, and the implementation or production phase. Figure 4.1 illustrates the framework of Chapter 4 as well as its orientation in the dissertation.

2. Planning, development and implementation of a Preventive Project

Before the planning, development and implementation of the Preventive Project are deliberated a short discussion on the theoretical framework of a project life cycle and project management is presented. Thereafter the Preventive Project of the SAMS is discussed through the stages; conceptual and planning phases, definition and design phase and the implementation phase.

2.1. Theoretical framework

According to Kerzner (1992, p 2) *a project* can be considered to be any series of activities and tasks that : [1] Have a specific objective to be completed within certain specifications; [2] Have defined start and end dates; [3] Have funding limits; and [4] Consume resources. With this background Kerzner (1992, p 4) defines *project management* as the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Furthermore, project management **utilizes the systems approach** to management by having functional personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy). According to De Wit and Hamersma (1992, p 302) the project life cycle (Figure

4.2) must be studied in order to understand project management. De Wit and Hamersma (1992, p 303) suggest that although each project has its own character, similar projects can show identical life cycle patterns. This life cycle includes the following five phases (De Wit and Hamersma, 1992, p 303):

- Conceptual phase
- Planning phase
- Definition and design phase
- Implementation phase
- Phasing-out phase

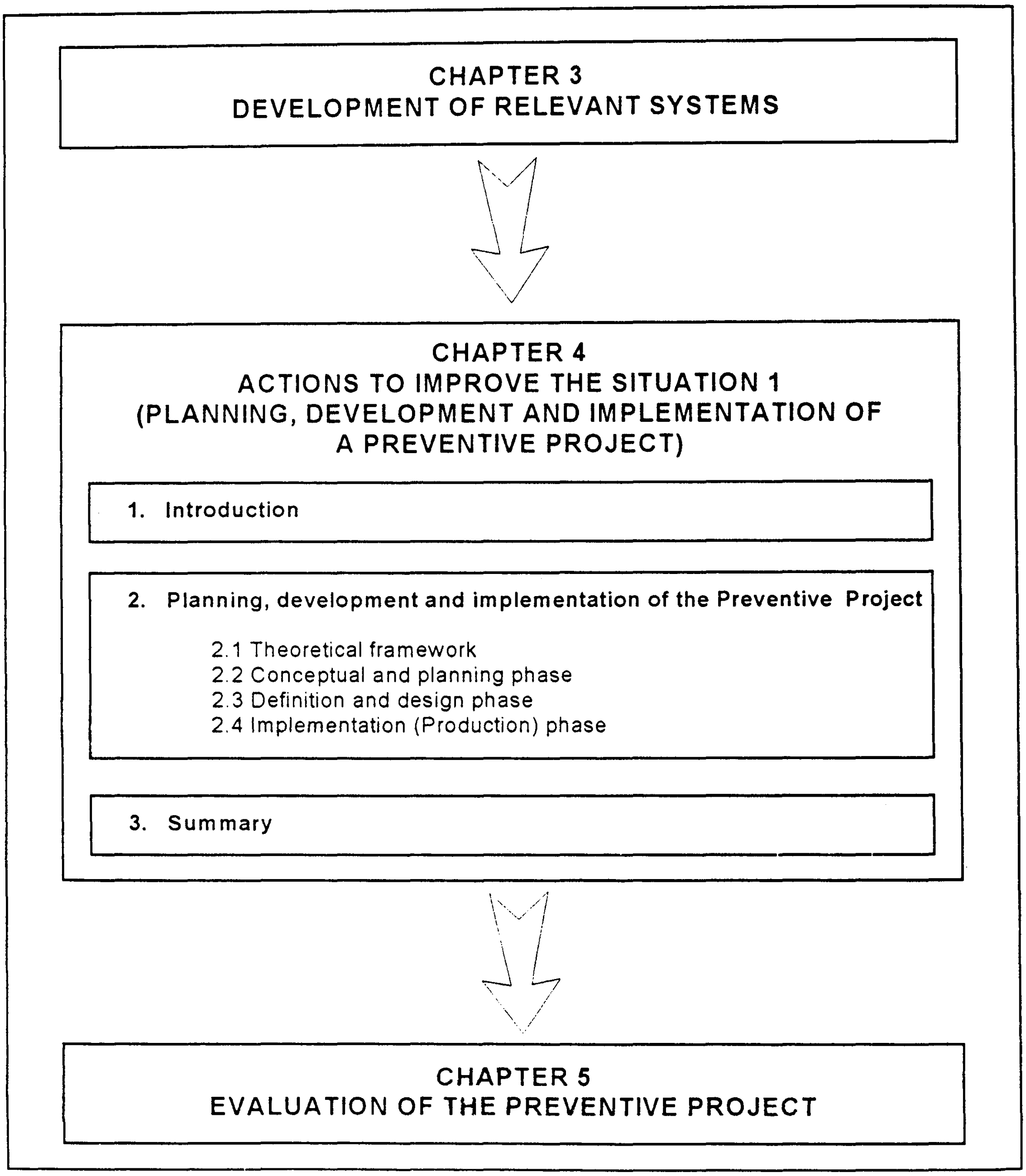

Figure 4.1: The conceptual framework of Chapter 4 as well as its orientation in the larger setting.

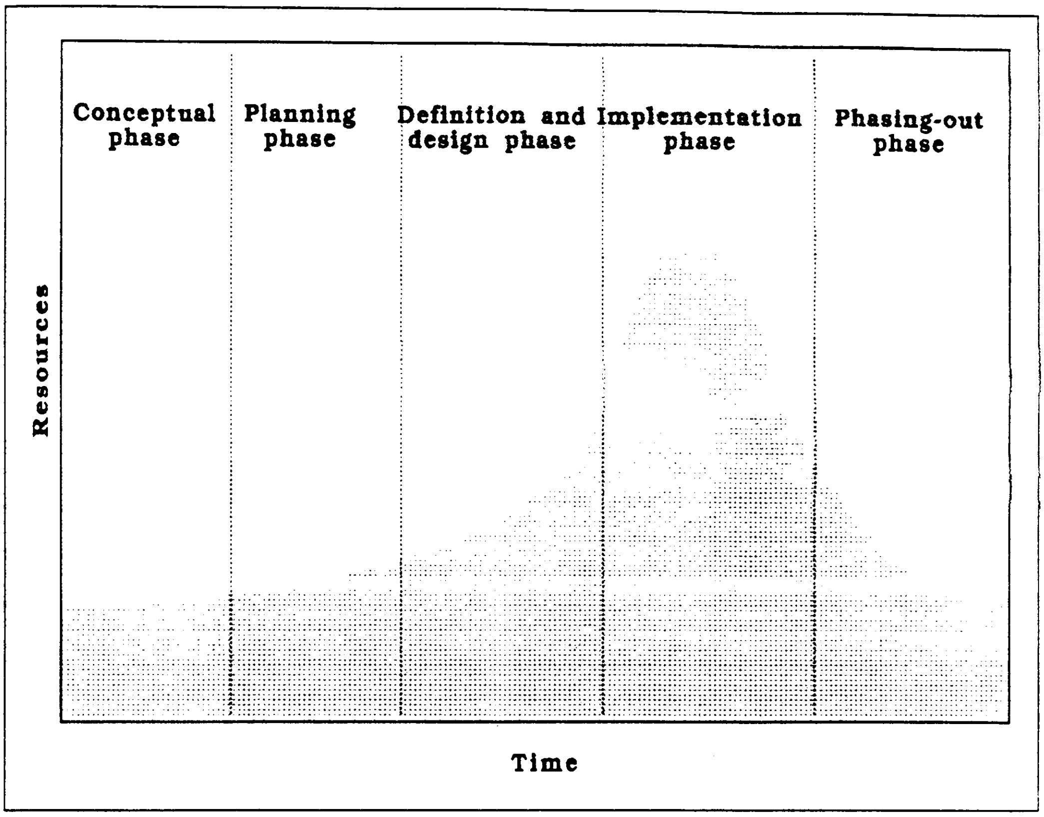

Figure 4.2: The project life cycle (De Wit and Hamersma, 1992, p 303)

Although this framework for project management was developed for the production (goods) industry, it is applicable with minor adjustments in the service industry.

The conceptual and planning phases, the definition and design phase as well as the components of the implementation phases are discussed in Chapter 4. The evaluation portion of the implementation phase as well as the phasing-out phase are discussed in Chapter 5. The conceptual and planning phases of the Preventive Project are subsequently discussed.

2.2. Conceptual and planning phases

These first phases include the preliminary evaluation, planning and feasibility of the idea (De Wit and Hamersma, 1992, p 303). According to Kerzner (1992, p 82) the following efforts attribute to this phase: [1] Determine existing needs or potential deficiencies of existing systems; [2] Establish system concepts which provide initial strategic guidance to overcome existing or potential deficiencies; and [3] Determine initial technical, environmental and economic feasibility and practicability of the system.

The epidemiological survey done by the Directorate Dentistry during 1987/88 laid the foundation for the planning and development of the Preventive Project. The conceptual foundation of these phases is discussed in Chapters 2 and 3. In this chapter the concept is qualified and quantified in more detail following the guidelines of Kerzner (1992, p 82). The first step was to identify the problems or according to Kerzner (1992, p 82) to determine existing needs or potential deficiencies of existing systems.

2.2.1. Problems identified. (Determine existing needs or potential deficiencies of existing systems)

The following are some of the problems that were identified from the epidemiological data:

- ⇨ 24,8% of children population (mean age = 13,14 years) was caries free. According to Ripa (1985, p 368) these children will show a decline in their oral health status by the time they reach adolescence.
- ⇨ The mean DMFT of the children group (mean age = 13,14 years) was moderate (3,92) in comparison to the other groups - indicating the possibility to increase but also the opportunity to prevent dental decay.
- ⇨ The first and second molars account for 80% of the dental caries in the children population group.
- ⇨ At least 85% of the dental caries involves pits and fissures.
- ⇨ Only 18% of the children population was responsible for 48% of total dental caries experience in that population
- ⇨ Only 74% of the total population used the dental services in the twelve months preceding the survey.
- ⇨ Only 60% of the SADF population use the dental services frequently as a good habit.
- ⇨ 99% of the SADF population brush their teeth once or more a day.

These problems clearly indicated the need for a Preventive System (Project) which preserves health and prevent disease. The next step was to establish the aim and the goals of the Preventive Project.

2.2.2. Aim and goals of the project. (Establish system concepts which provide initial strategic guidance to overcome existing or potential deficiencies)

The aim of the Preventive Project was to plan and implement a preventive project (pit and fissure sealant project) that would prevent mainly pit and fissure caries in selected groups. (For a complete discussion on pit and fissure sealants see Appendix B)

The goals of the project were stated as follows:

- ⇨ To preserve oral health in the children population group by restraining the decline in percentage caries free children which is associated with age.
- ⇨ To lower the DMFT at age 13, and to prevent the rise in DMFT beyond the age of 13.
- ⇨ To plan and implement a pit and fissure sealant programme to prevent the 85% pit and fissure caries of permanent molars.
- ⇨ To develop and use selection criteria in order to identify at risk children and teeth.
- ⇨ To enhance the accessibility of the service.

There was no doubt that the realization of the goals would benefit the oral health of the population. The next step was to determine the initial feasibility, acceptability and vulnerability of the Preventive Project.

2.2.3. Determine the initial feasibility, acceptability and vulnerability of the Preventive Project

During the initial evaluation of the project the SAMS followed the guidelines of Cooke and Slack (1984, p 283). Cooke and Slack evaluate an option by using three classes of evaluation criteria, namely [1] feasibility, [2] acceptability and [3] vulnerability.

2.2.3.1. Feasibility

Table 4.1 is a representation of the criteria assessed during the initial feasibility evaluation.

Feasibility criteria	Positive	Unsure	Negative
1. Skills required for implementation	X		
2. Effect on overall services	X		
3. Financial requirements	X		
4. Interaction with overall services	X		

Table 4.1: Assessment of feasibility criteria

Table 4.1 clearly indicated the feasibility of the project.

2.2.3.2. *Acceptability*

The acceptability of the project was assessed by evaluating its operational impact on the criteria listed in Table 4.2.

Acceptability criteria	Positive	Unsure	Negative
1. Technical specifications of service (Does the project increase the likelihood that the service will be closer to what the clientele want)	X		
2. Quality of service (Does the project enhance quality and therefore reduce the chance of errors)	X		
3. Responsiveness of the project (Does the project shorten the time patients have to wait for oral health)	X		
4. Dependability of the project (Does the project give an increased chance of things happening when they are supposed to happen)	X		
5. Flexibility of the project (Does the project increase the flexibility of the service)		X	

Table 4.2: Assessment of acceptability criteria

Table 4.2 clearly indicated the acceptability of the project.

2.2.3.3. *Vulnerability*

According to Cooke and Slack (1984, p 296) the vulnerability of an option is determined by the effect of the option on external and internal stakeholders. The SAMS identified the school system as the most significant external stakeholder. The school system entails the schools *per se* and the higher bureaucracy, namely the Transvaal Educational Department (TED).

It was thus necessary that a few school principals be contacted in order to establish a working relationship and collect information as to when the schools were in session, when the children would be available for examination and treatment, whether there were suitable rooms or areas that could be used for the examination and treatment and any other possible problems to be avoided when implementing the programme. Principals from the following schools were contacted to enhance the quality of planning and reduce vulnerability:

- ⇨ Erasmia Laerskool
- ⇨ Fleur Laerskool
- ⇨ Valhalla Laerskool
- ⇨ Springvale Primary

The principals were very positive and only minor issues were identified for the implementation of the programme. They only insisted on being informed a month in advance in order to plan their school activities accordingly.

The second important external stakeholder, namely the TED was approached by the SAMS via a letter explaining the project and its objectives, and requesting permission to implement the project in identified primary schools.

The internal stakeholders of the projects were identified as [1] the Officer commanding (OC) the Northern Medical Command, [2] the dental team of the Northern Medical Command including the Dental Staff Officer, the dental officers in charge of dental clinics, the dentists in dental clinics and the auxiliary dental staff, and [3] the section Logistics at the Northern Medical Command. Possible difficulties these internal stakeholders could have with the implementation of the project were:

- ⇨ Fear of more work
- ⇨ Not accepting the concept
- ⇨ Resistance to change
- ⇨ Refusing support for the project
- ⇨ Lack of available of manpower

To counter these possible problems the following actions were taken:

- ⇨ Surgeon General authorization for the project was requested and granted.
- ⇨ A letter explaining the concept and requesting support was addressed to the Officer Commanding Northern Medical Command and his Dental Staff Officer.
- ⇨ Manpower support was requested and granted from the Department of Community Dentistry, Dental Faculty, University of Pretoria.

It was concluded that the Preventive Project was feasible, acceptable and with certain pre-emptive steps the vulnerability was reduced to a minimum. The next step was to examine the alternative ways of accomplishing the system (Preventive Project) objectives.

2.2.4. Examine alternative ways of accomplishing the system objectives

There were three ways in which a fissure sealant project for the children population of the SADF could be implemented, namely:

2.2.4.1. Option 1

Visit primary schools with mobile equipment, examine children, determine risk, do the necessary fissure sealants on site and refer children with curative needs to dental clinics by a letter informing their parents concerning their oral health status and treatment needs.

2.2.4.2. Option 2

Visit primary schools, examine children, determine risk and refer children for fissure sealants and curative needs to dental clinics. The children are transported during the school day to dental clinics to apply fissure sealants.

2.2.4.3. Option 3

Children are transported during school time to dental clinics where they are examined, risk is determined, fissure sealants are done and their parents are informed by a letter concerning their oral health status and treatment needs.

These options were evaluated according to the criteria in table 4.3. Each criterion was evaluated on a scale from 1 to 10 where 1 indicates the worst value and 10 the best value.

Alternative criterion	Option 1	Option 2	Option 3
1. Feasibility of the option	8	8	8
2. Acceptability of the option	8	6	4
3. Vulnerability of the option	8	6	4
TOTAL	**24**	**20**	**16**

Table 4.3: Assessment of the options available

According to the assessment in Table 4.3 the Dental Service of the SAMS decided that option 1 was the most viable way to implement the project. The next step was to identify the human and non-human resources required to support the system (Preventive Project).

2.2.5. Identify the human and non-human resources required to support the Preventive Project

The following resources were identified to support the project:

- ⇨ Dental personnel to examine the children.
- ⇨ Dental personnel to do fissure sealants.
- ⇨ Auxiliary personnel to assist the dental personnel.
- ⇨ Personnel to help with the transition of equipment and personnel.
- ⇨ Materials to do fissure sealants (detailed discussion later).
- ⇨ Vehicles to transport equipment and personnel.
- ⇨ Documents needed to support the project, such as survey forms, referral forms, operation diaries, policies and procedures (detailed discussion later).

Following this crude identification of human and non-human resources required, some critical questions concerning the operationalization of the Preventive Project were answered.

2.2.6. Initial answers to questions

Preliminary answers were generated to what the Preventive Project would cost, what the Preventive Project would do and how the Preventive Project would be integrated into existing systems.

2.2.6.1. What would the system cost

The per annum cost of the project was initially determined as indicated in Table 4.4.

Description	Cost
1. Personnel	10 000,00
2. Materials	6 000,00
3. Transport	1 000,00
4. Administrative	800,00
5. Data capturing and analysis	1 200,00
6. Sundries	500,00
TOTAL	19 500,00

Table 4.4: Cost estimation of the oral health system

2.2.6.2. *What would the system do*

In brief the project (sub-system) would do the following:

- ⇨ Primary schools in Pretoria would be visited with mobile equipment.
- ⇨ Children of SADF members would be examined.
- ⇨ Epidemiological status (only caries) would be determined.
- ⇨ Caries treatment and fissure sealant needs would be recorded.
- ⇨ Fissure sealants would be placed if necessary.
- ⇨ Children with other curative dental treatment needs would be referred to dental clinics.
- ⇨ Parents would be informed about the dental status of their children.
- ⇨ The project would be evaluated annually.

2.2.6.3. *How would the system be integrated into existing systems*

The integration of the project (sub-system) with existing systems can be described as follows (see also Figure 4.3):

- ⇨ During the implementation of the project this sub-system would be supported by manpower from the existing dental delivery system.
- ⇨ Children referred to dental clinics would probably burden the already overworked dental clinics.
- ⇨ The prevention of dental decay would release the curative encumbered dental clinics.
- ⇨ The equipment, materials and transport for the project would be provided by the Logistical sub-system of the Northern Medical Command.

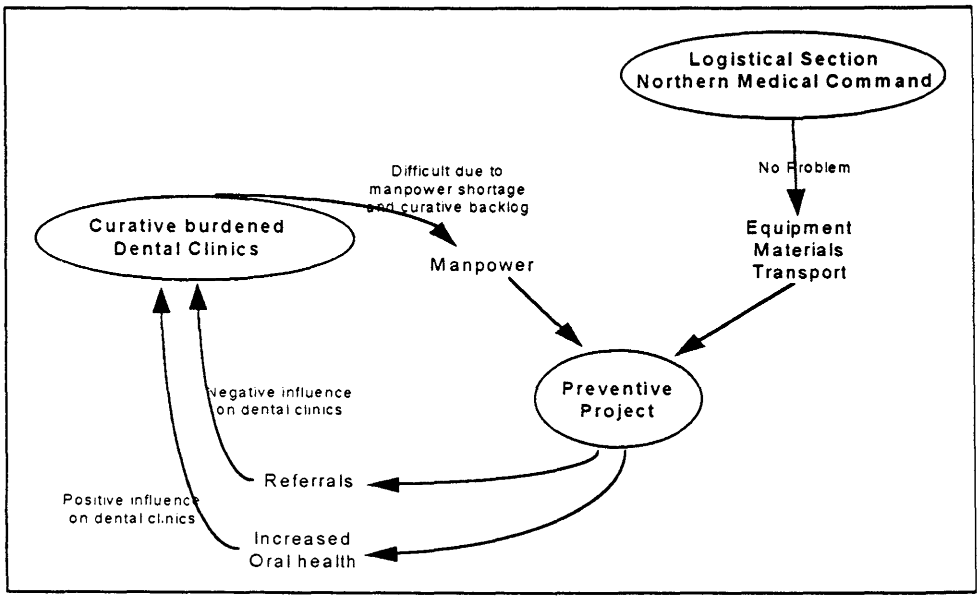

Figure 4.3: An illustration of the integration of the Preventive Project into existing systems.

Having answered these operational questions the next step was to give attention to some ethical issues.

2.2.7. Ethics and other aspects

Like all research, evaluation research does not occur in an ethical vacuum. Evaluation research involves trying to serve four masters: the researcher, the programme clients, the programme staff and the programme manager. In the ideal world these four masters share the common goal of obtaining sufficient information to decide the best way to implement a programme to solve a problem. The most important ethical issues are discussed below.

2.2.7.1. Withholding potential benefits

The main ethical issue in evaluation research is normally the withholding of benefits to potential programme clients (patients) or on the other hand failing to adequately test a programme before implementing it.

The safety, efficacy and effectiveness of fissure sealants were tested by many researchers, which eliminate the ethical issue of an inadequately tested programme.

Concerning the withholding of potential benefits all the subjects would be treated in the same way except those children in the schools that would not be included in the study (see discussion under Study population - Chapter 4, paragraph 2.3.1.1). These children however have the right to visit any military dental clinic to receive the same treatment and advantages.

2.2.7.2. Formulation and negotiation

Before starting this evaluation study all parties involved were informed about the methods, the rationale and the shortcomings of the project in order to reach a mutual understanding of the task. This was done by informal meetings, the presentation of the research protocol and letters of permission as well as informed consent, as discussed in this chapter, paragraph 2.4.1.

2.2.7.3. Structure and design

In addition to methodological interests, the design of an evaluation project is influenced by logistical, political, ethical and fiscal concerns. Such influences are not, however, sufficient reason for failing to provide the best possible design, regardless of the type of evaluation chosen. The design and evaluation methods are discussed elsewhere and were according to international standards.

2.2.7.4. Data collection and preparation

The main issue here is training and supervising to ensure that those collecting the data are following the proper procedures. Firstly the training and calibration of team members took place at the Dental Faculty of the University of Pretoria. The training and calibration session under supervision of the project co-ordinator was conducted a week before the start of the project.

For the recording of epidemiological data and treatment needs the objectives of standardization and calibration were:

- ⇨ To ensure uniform interpretation, understanding and application of the criteria for the various disease conditions to be observed and recorded;
- ⇨ To ensure that each examiner can examine to a "uniform" standard; and
- ⇨ To minimize variations between different examiners.

The following method was used to standardize and calibrate the examiners :

- ⇨ Thorough discussion of the criteria involved
- ⇨ The use of colour slides to identify all the possible clinical situations
- ⇨ Finally, calibration and standardization on fifty patients.

Intra- and inter-examiner consistency were set to be at a level of 0,8 according to the Kappa statistics.

The training for the fissure sealant programme was done by means of audio-visual material from Medunsa.

Secondly to reduce the tendency of examiners to change the way they apply diagnostic criteria during the course of a long series of examinations, and to measure the extent of change, duplicate examinations on 10% of all the participants were done.

2.2.7.5. *Data capturing, analysis and interpretation*

Data capturing was performed by INFO-Plan. INFO-Plan provided the captured data on a floppy disk for analyses by the section Bio-Statistics, Medical Research Council (MRC), Pretoria.

A biostatistician at the MRC assisted the project manager in the analysis and interpretation of the data. The project manager consulted other researchers to assist where necessary.

2.2.7.6. *Communication and disclosure*

Reports were presented to the authorities concerned during the different phases of the project. This dissertation is the project manager's final report on the project fulfilling the requirements for obtaining the MChD degree, and manuscripts will be submitted for publication in journals concerned.

2.2.7.7. *Use of the results*

Because evaluation research is invariably conducted to provide information to those who make decisions, results will be presented as soon as possible in order to permit the necessary changes. The results will be used by the project manager to make appropriate policy recommendations.

Having considered the ethical issues concerned the final step in the conceptual and planning phase of the Preventive Project was to get authorization for implementation.

2.2.8. Authorization

Permission to examine and preventively treat the children concerned, was obtained from the following institutions :

- ⇨ Chief Medical Force Application (SAMS)
- ⇨ Director Oral Health (SAMS)
- ⇨ Transvaal Educational Department
- ⇨ Department of National Health and Population Development
- ⇨ Principals of Primary schools

After authorization was granted by the CMF Application and the Director Oral Health (SAMS), letters to request permission from and explain the purpose of the survey to the TED were written via the Director Oral

Health. The rest of the authorizations were done by oral communication. The dental clinics of SAMS in the Pretoria area were acquainted in order to ensure their co-operation.

The issue of informed consent is discussed in this chapter, paragraph 2.3.1.1.

The Conceptual and Design phase was discussed in eight steps, namely, problems identified, aim and goals of the project, initial feasibility, acceptability and vulnerability, alternatives to accomplish the system objectives, human and non-human resources required, initial answers to operational questions, ethical issues and authorization for the project. The definition and design phase is described hereafter.

2.3. Definition and design phase

This phase is mainly a refinement of the elements described under the conceptual and planning phase. The definition and design phase includes according to Kerzner (1992, p 83) the following elements: [1] Firm identification of human and non-human resources required; [2] Preparation of detailed plans to support the project; and [3] Identification and preparation of the documents required to support the project. The first step was to firmly identify human and non-human resources required.

2.3.1. Firm identification of human and non-human resources required

To be able to firmly identify the human and non-human resources required the target population is described in more detail

2.3.1.1. Study population

The study population consisted of the following :

⇨ Primary school children of SADF members

⇨ Six to eight and eleven to thirteen years old

⇨ From seventeen primary schools in Pretoria

Due to the research design (oral health system research) all the SADF children in the selected schools would be part of the programme or study. It was not a comparative study between two groups or a split mouth design. The research is thus not only aiming at the evaluation of the efficacy and effectiveness of pit and fissure sealants, but primarily at the efficiency of fissure sealants and the evaluation of the service in total.

The age categories six to eight and eleven to thirteen were selected because of the higher caries risk (erupting first and second molars) in these groups.

The criteria to select the primary schools were based upon the number of SADF children in the particular school. A school was selected when twenty or more children could benefit from the programme. The schools in Table 4.5 were identified after receiving an indication from all the primary schools in Pretoria about the number of SADF children attending the school in 1990.

School	Number of children
Bakenkop Laerskool	61
Booyens Laerskool	22
Derdepoort Laerskool	24
Elarduspark Laerskool	50
Erasmia Laerskool	40
Fleur Laerskool	48
Gen A Brink Laerskool	274
Hennopspark Laerskool	53
Hermanstad Laerskool	35
Louis Leipoldt Laerskool	66
Lyttleton Primary	28
Silverton Laerskool	21
Springvale Primary	30
Swartkop Laerskool	58
Tuinrand	22
Valhalla Laerskool	127
Valhalla Primary	63
Wierdapark Laerskool	80
Total	1102

Table 4.5: Primary schools identified to be incorporated in the preventive programme with the number of SADF children in each school.

From Table 4.5 detailed planning for 1990 was possible. The first step was to calculate the approximate time required, whereafter the following were identified; the field teams, the personnel requirement, the instruments, the equipment, the materials, the transport, the sterilization procedures, the facilities and finally the financing of the Preventive Project.

2.3.1.2. Time required

To calculate the approximate time required per school three steps were followed, namely: [1] Calculate the total time required for the placement of all the expected sealants; [2] Calculate number of children sealed per dental team per school session; and [3] Calculate the number of sessions needed per school.

2.3.1.2.1. Time required for the placing of sealants :

a.	6- to 8-year children	:	20 minutes/child
b.	10- to 13-year children	:	12 minutes/child
d.	Calculation :		
	Average time needed	=	15 minutes
	Expected number of children	=	1200
	Total time needed	=	1200 x 15 minutes
		=	18 000 minutes
		=	300 hours
	Number of hours per school session	=	5
	Number of school sessions needed	=	300/5
		=	60 school sessions

2.3.1.2.2. Number of children sealed per team per school session :

a.	Number of minutes per school session	=	300 minutes
b.	Average sealing time	=	15 minutes
c.	Calculation :		
	Number of children/team/school session	=	300/15
		=	20

2.3.1.2.3. Number of sessions needed per school :

a.	Number of children/team/school session	=	20
b.	Number of sessions per school	=	Number of children/20
c.	Calculation (Table 4.6) :		

School	Number of children	Number of sessions
Bakenkop Laerskool	61	3
Booyens Laerskool	22	1
Derdepoort Laerskool	24	1
Elarduspark Laerskool	50	3
Erasmia Laerskool	40	2
Fleur Laerskool	48	3
Gen A Brink Laerskool	274	14
Hennopspark Laerskool	53	3
Hermanstad Laerskool	35	2
Louis Leipoldt Laerskool	66	3
Lyttleton Primary	28	2
Silverton Laerskool	21	1
Springvale Primary	30	2
Swartkop Laerskool	58	3
Tuinrand	22	1
Valhalla Laerskool	127	6
Valhalla Primary	63	3
Wierdapark Laerskool	80	4
Total	1102	57

Table 4.6: Calculated number of session per school needed.

According to these calculations approximately 57 school sessions (or school days) were required to implement the project. This implied that the duration of the project would be 12 weeks with one dental team (field team) working. In order to complete the project in the shortest time, four different field teams would visit separate schools at the same time.

2.3.1.3. *Field teams*

These dental teams would exist of 1 dentist (examiner), 1 recording clerk, 1 oral hygienist (doing fissure sealants) and 1 dental assistant.

2.3.1.4. *Personnel*

The following people were selected to be part of the project.

1. Guardian : Director Oral Health (SAMS)
2. Project advisor and co-ordinator : Prof LM Rossouw
3. Project manager : Maj JH Viljoen
4. Field teams : 1 x project manager
   4 x examiners (calibrated dentists)
   4 x recording clerks
   4 x oral hygienists (fissure sealants) (University of Pretoria)
   4 x dental assistants
   1 x organizing clerk

2.3.1.5. Instruments

The instruments in Table 4.7 would be used during the project :

Instrument	Quantity
a. Caries explorer (No 54)	80
b. Plane mouth mirrors	80
c. Tweezers	20

Table 4.7: Instruments needed for the Preventive Project.

These instruments would be provided by the University of Pretoria.

2.3.1.6. Equipment

The equipment in Table 4.8 would be used during the survey :

Equipment	Quantity	Provider
a. Portable dental chair	4	Univ. Pretoria
b. Portable dental unit	4	Northern Med Com
c. Portable suction unit	4	Northern Med Com
d. Portable dental light	4	Northern Med Com
e. UV light	2	Northern Med Com

Table 4.8: Equipment needed in the 1990 Preventive Project.

2.3.1.7. Material

The consumable and non-consumable items in Table 4.9 would be needed :

Material		Quantity
a.	Fissure sealant (Chemical hardening) *Delton*	10 boxes
a.	Fissure sealant (Light hardening) *Delton*	6 boxes
c.	Hand soap *Hibiscrub*	6 bottles
d.	Hand towels	6/day/team
e.	Surgical masks	16/day/team = 1 216
f.	Cotton rolls	100/day/team = 7 600
g.	Gloves	16/day/team = 1 216
h.	**Stationery :**	
	Pencil	8/team
	Rubbers	4/team
	Sharpeners	4/team

Table 4.9: Consumable materials needed for the 1990 Preventive Project.

The materials would be provided by the Logistical section of the Northern Medical Command. The form in Appendix J would be used to calculate the exact quantity of materials used.

2.3.1.8. *Transport*

Military transport would be used to transport team members and equipment between the Northern Medical Command HQ, the Dental Faculty and the primary schools concerned. The logistical section of the Northern Medical Command would co-ordinate the transport.

2.3.1.9. *Sterilization procedures*

Sterilization was planned according to the protocol of the National Oral Health Survey.

2.3.1.10. *Facilities*

The schools concerned would provide the necessary examination areas. The area should be safe for the storage of equipment.

The final dates of the project would be provided to the schools concerned a month in advance in order to give them the necessary time to make time-table adjustments.

2.3.1.11. Finance

No additional funds would be required for the implementation of the Preventive Project, due to the following reasons :

- ⇨ The project would be performed as part of the normal service of the South African Medical Service.
- ⇨ Manpower being used would be part of the SAMS or the University of Pretoria.
- ⇨ The equipment, instruments and materials were available in the normal rendering of services.

Due to the kind of research (action research) the cost of the programme was however defined as accurately as possible (Table 4.10).

	Description	Amount
a.	**Administrative :**	
i.	Envelopes	200,00
ii.	Printing of letters	230,00
iii.	Stationery	100,00
iv.	Survey forms	110,00
v.	Telephone	50,00
b.	**Transport :**	
i.	Personnel (15 seater)	420,00
ii.	Equipment (1,5 ton LDV)	300,00
c.	**Computer :**	
i.	Data capturing *	5 250,00
ii.	Data analysis	1 260,00
d.	**Materials :**	
i.	Fissure sealants	3 700,00
ii.	Gloves, masks, hibitane	2 500,00
e.	**Personnel :**	
i.	Project Manager	3 500,00
ii.	Calibrated Dentists	2 000,00
iii.	Oral Hygienists (Students)	0,0
iv.	Dental Assistants	2 000,00

e. **Sundries :**	
i. Miscellaneous	500,00
TOTAL	22 120,00
* The data capturing expense would be saved by using INFO-plan. This would bring the total cost down to R16 870,00.	

Table 4.10: Final calculation of the cost of the Preventive Project.

The discussion above considered all human and non-human resources needed to support the Preventive Project. The preparation of detailed plans is subsequently discussed.

2.3.2. Preparation of detailed plans to support the system

The only issue that still needed clarification was the time schedule of the Preventive Project.

2.3.2.1. Time schedule

The first phase of the project would start on 5 March 1990 and would continue until 30 March 1990. The yearly follow-ups were also planned for the first school term.

2.3.2.1.1. Dates for the first phase (1990) of the project

The programme was planned for the weeks of :

a. 5 to 9 March 1990
b. 12 to 16 March 1990
c. 19 to 23 March 1990
d. 26 to 30 March 1990

2.3.2.1.2. Programme for Day One :

Reporting at Northern Medical Command HQ	:	07h00
Departure from HQ	:	07h10
Travelling time	:	40 minutes
Arrival at schools	:	07h50
Setting up equipment	:	30 minutes
Execution of programme	:	240 minutes
Closing down	:	13h30
Administration and setting up at next school	:	14h00

Having set up detailed plans regarding the resources needed and the time schedule of the Preventive Project for implementation during 1990 the next step was to identify and prepare documents required to support the system.

2.3.3. Identification and initial preparation of the documents required to support the system, such as indexes, criteria, survey :ms, job descriptions, equipment and material control forms, and letters

The documents required are divided and discussed under two headings, the first being health related namely indexes, criteria and survey forms, and the second being management related namely job descriptions, equipment and material control forms, and letters.

2.3.3.1. Indexes, criteria and survey forms

The diagnostic criteria that would be used are promoted by the WHO (1987). The following indexes were used with minor adjustments:

1.	DMFT and dmft indexes	-	Appendix D
2.	Treatment needs	-	Appendix E
3.	Fissure sealant criteria	-	Appendix F
3.	Preventive-therapeutic sealant criteria	-	Appendix F
4.	Preventive resin restoration criteria	-	Appendix F
5.	Survey form	-	Appendix G
6.	Evaluation criteria	-	Appendix H

2.3.3.2. Job descriptions, equipment and material control forms, and letters

The following supporting documentation were used:

- Job description for team leaders and dentists - Appendix I
- Issue form for the control of equipment, instruments and materials - Appendix J
- Diary to record the daily work flow and hours of work - Appendix K
- To the parents concerned
  - A letter of information - Appendix L
  - An informed consent form - Appendix L

- From dental team to parents concerned about the oral health status of their children, for the purpose of reference to dental clinics - Appendix M

After the completion of the definition and design phase the Preventive Project was implemented as subsequently discussed.

2.4. Implementation (production) phase

During this phase the actual production (delivery of a service) commenced. This means that this phase can be regarded as the actual integration of the project's services into the existing organizational functioning (De Wit and Hamersma, 1992, p 305).

The project was conducted during the years 1990, 1991 and 1992. A framework for the total project is presented in Figure 4.4. There were five longitudinal groups followed up for two years, eight longitudinal groups followed up for one year and forty-one cross sectional groups. The data gathered in 1990 were used as baseline data to evaluate the impact of the Preventive Project on the health status of the population.

The implementation during each year is discussed in detail, after giving attention to *Informed consent* which preceded every year's project.

2.4.1. Informed consent

The parents of the children concerned were informed in two ways.

- A signal was sent to all units in the Pretoria-area to inform parents via unit orders
- Letters of information were sent to all parents concerned via their children
- An informed consent form which was part of the letter of information was used to get written consent from all the parents whose children would partake in the study.

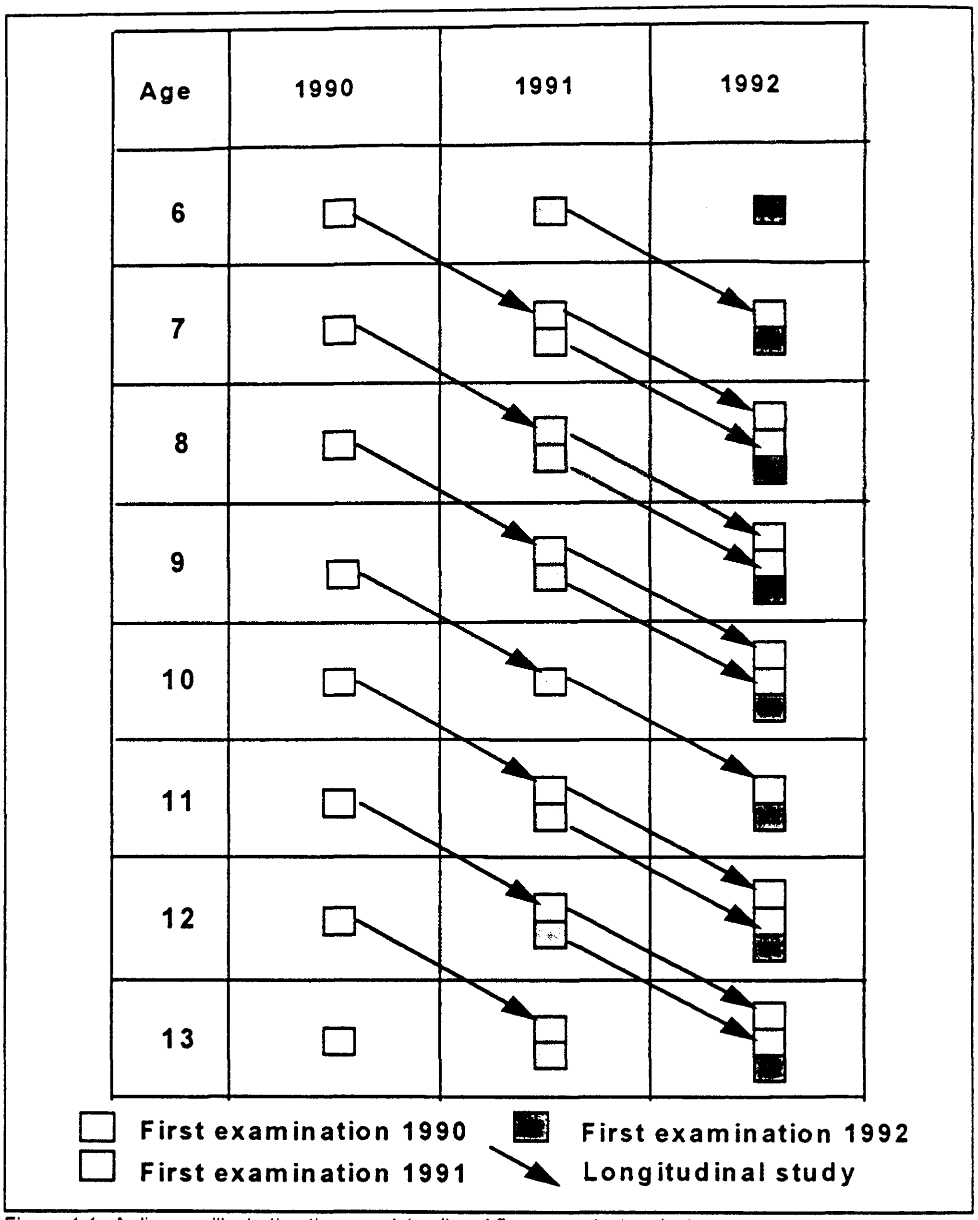

Figure 4.4: A diagram illustrating the complete pit and fissure sealant project

2.4.2. Implementation during 1990

The project was implemented according to the plan discussed in the first section of this chapter. The epidemiological data recorded during 1990 would be used as baseline data to evaluate the impact of the Preventive Project on the oral health status of the population. The implementation during 1990 is discussed following the framework of process, output and input. The process followed during 1990 as well as the epidemiological data recorded are firstly deliberated.

2.4.2.1. Process

During 1990 four dental teams visited the 17 primary schools. The process followed by each team is presented in Figure 4.5.

During this process epidemiological data (caries status) were collected, that would serve as baseline data to evaluate the impact of the project. The caries status of the population is described as: [1] Percentage of children free from caries experience; [2] Percentage of children contributing to percentage of total caries; [3] DMFT per age group; [4] DMFT per tooth; and [5] DMFS per tooth surface.

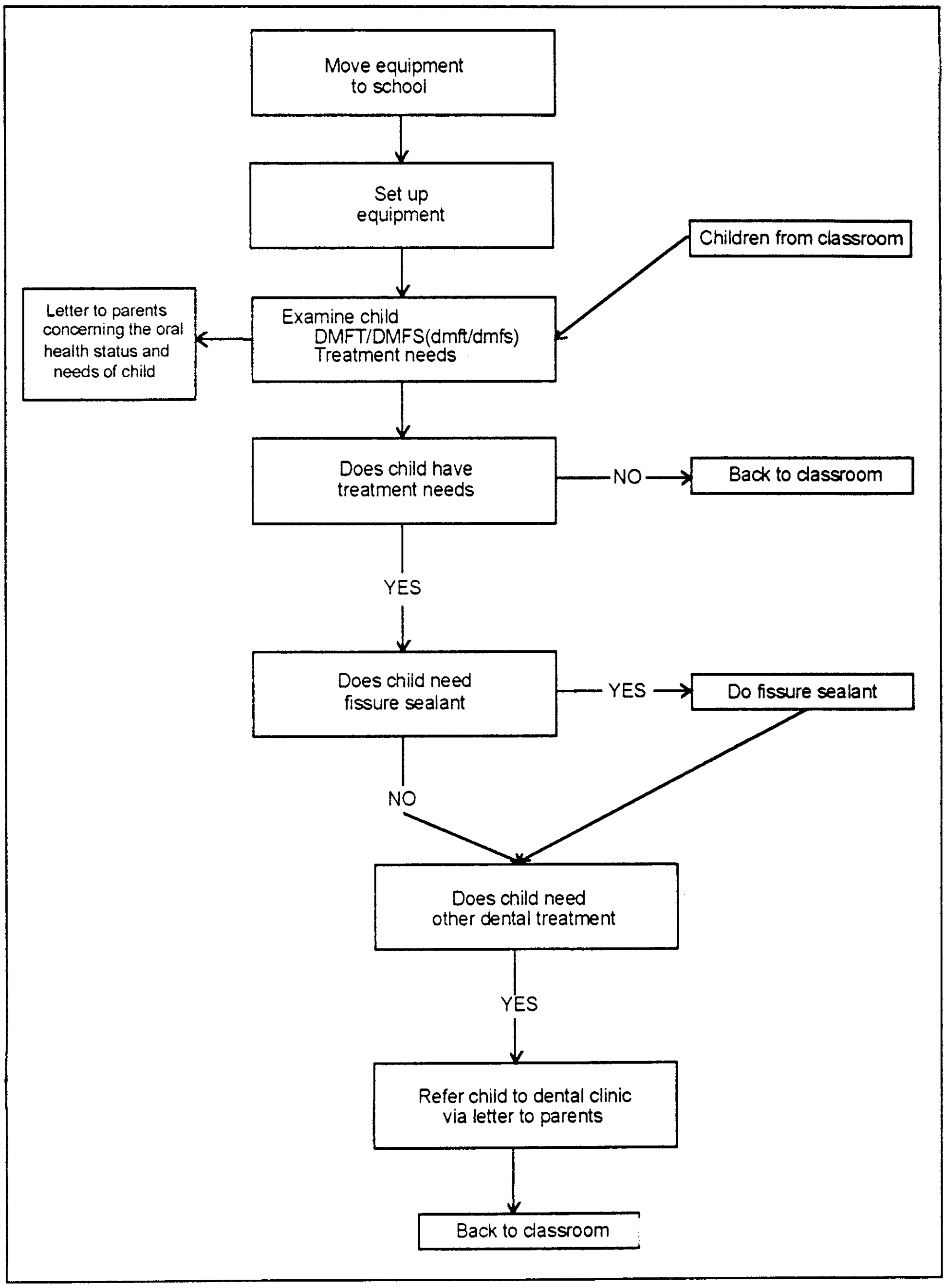

Figure 4.5: Flow diagram of the process followed by every dental team at each primary school.

2.4.2.1.1. Caries free children per age group

Figure 4.6 presents the percentage of children free from caries experience in the age groups 5 to 13 years. It also attempts to project the trend of the decline in percentage of children free from caries experience.

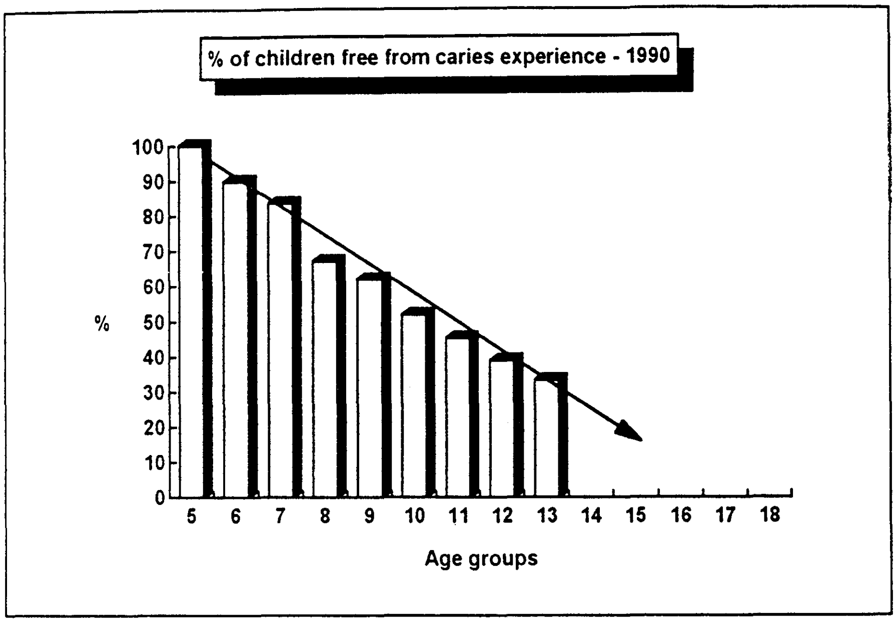

Figure 4.6: Percentage of children free from caries experience in the different age groups.

This decline is alarming, projecting to a possible zero percent of children free from caries experience at the age of 18.

2.4.2.1.2. Percentage of children contributing to percentage of total caries in population

Table 4.11 presents the percentage of children contributing to the percentage of caries in the total population per age group.

Age group	% of population	% of caries
6 Years	5	73
7 Years	8	82
8 Years	14	71
9 Years	14	75
10 Years	30	83
11 Years	27	72
12 Years	32	78
13 Years	33	76

Table 4.11: The percentage of the population contributing to the percentage of the total caries in the different age groups

From Table 4.11 it is clear that 33% or less of the population contributes to 70% and more of the caries in the total population. The identification of these "at elevated risk" children is essential in order to make any Preventive Project efficient.

2.4.2.1.3. DMFT per age group

Table 4.12 presents the DMFT (by component and in total) in the age groups 6 to 13 years. Figure 4.7 illustrates the rise in DMFT from 5 to 13 years as well as the increment per age group. The arrow in Figure 4.7 also projects a possible "caries future" for these age groups.

Age ⇨	6	7	8	9	10	11	12	13
N	169	227	70	50	27	124	193	54
D	0.112	0.154	0.357	0.320	0.222	0.419	0.585	0.648
M	0.000	0.004	0.014	0.000	0.000	0.016	0.016	0.093
F	0.083	0.106	0.271	0.520	0.852	1.016	1.249	1.370
DMFT	0.195	0.264	0.642	0.840	1.074	1.451	1.850	2.111

Table 4.12: A comparison between the DT, MT, FT and DMFT of the different age groups.

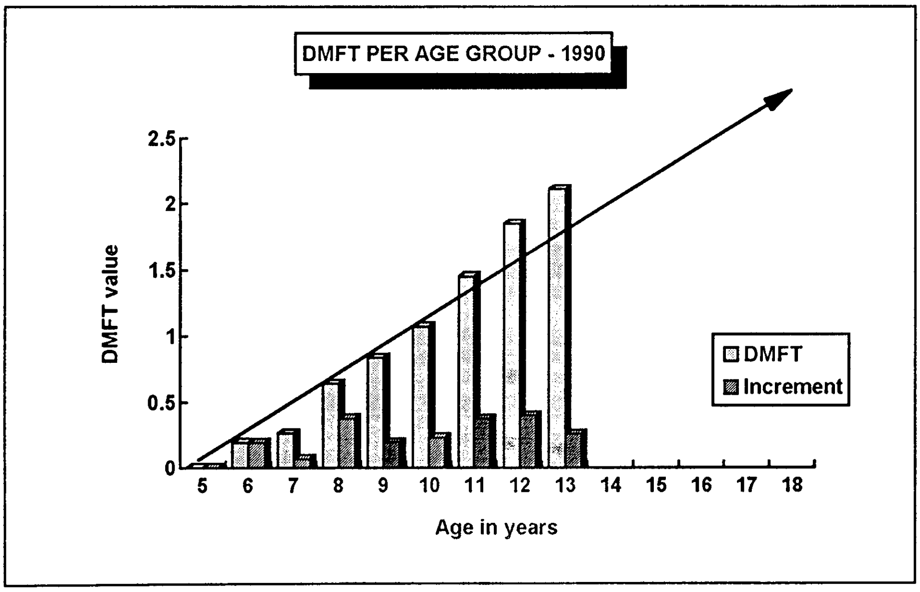

Figure 4.7: The tendency in DMFT from the age of 5 to 13, and the increment per age group.

2.4.2.1.4. DMFT per tooth in ages 6, 9 and 12

The DMFT per tooth for the 6 year old children is illustrated by Figure 4.8, for the 9 year old children by Figure 4.9 and for the 12 year old children by Figure 4.10.

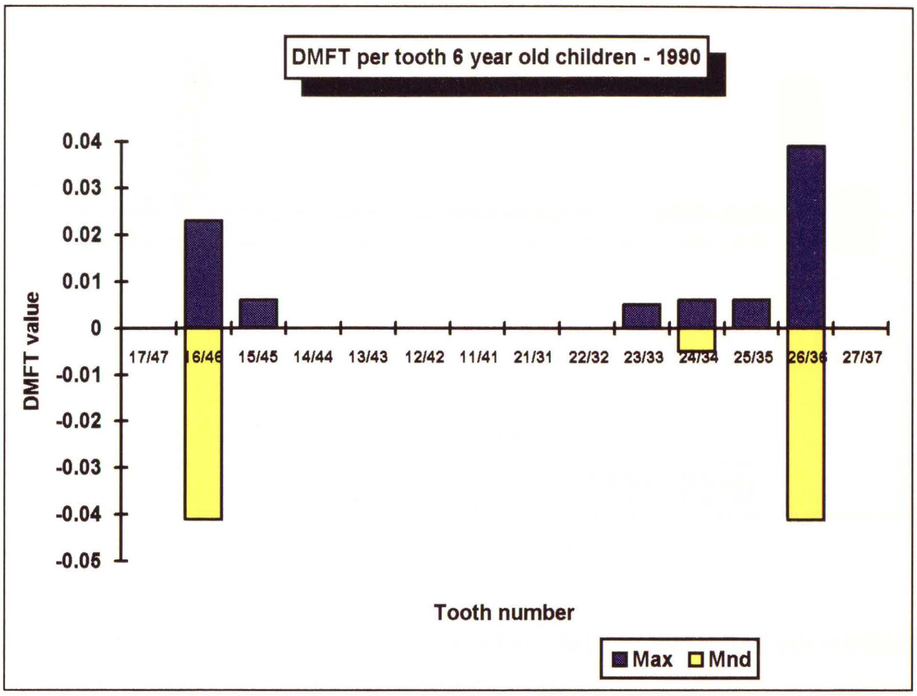

Figure 4.8: DMFT per tooth for the 6 year old children - 1990

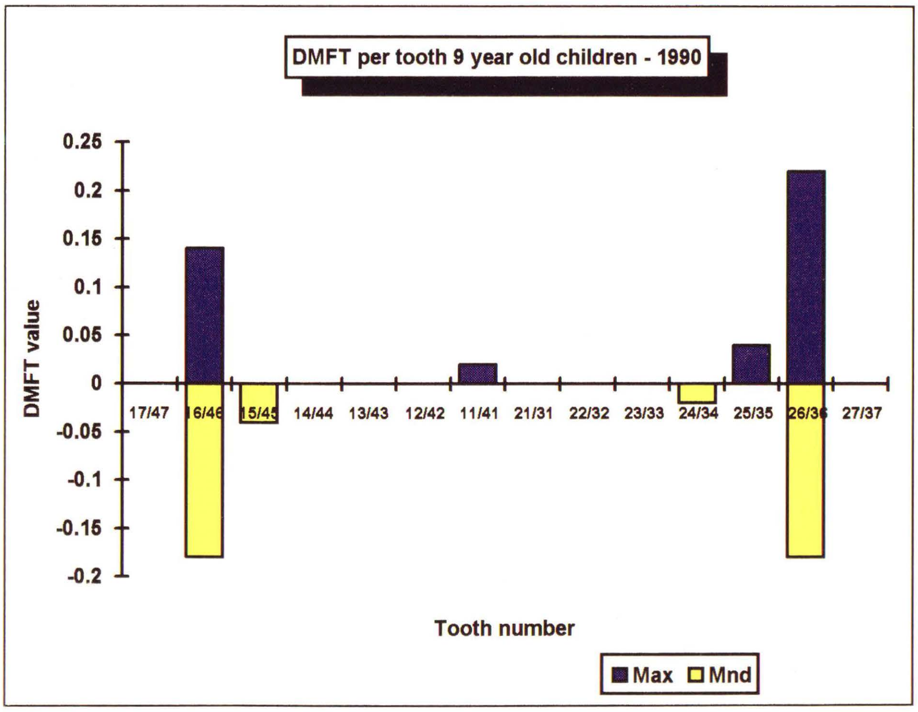

Figure 4.9: DMFT per tooth for the 9 year old children - 1990

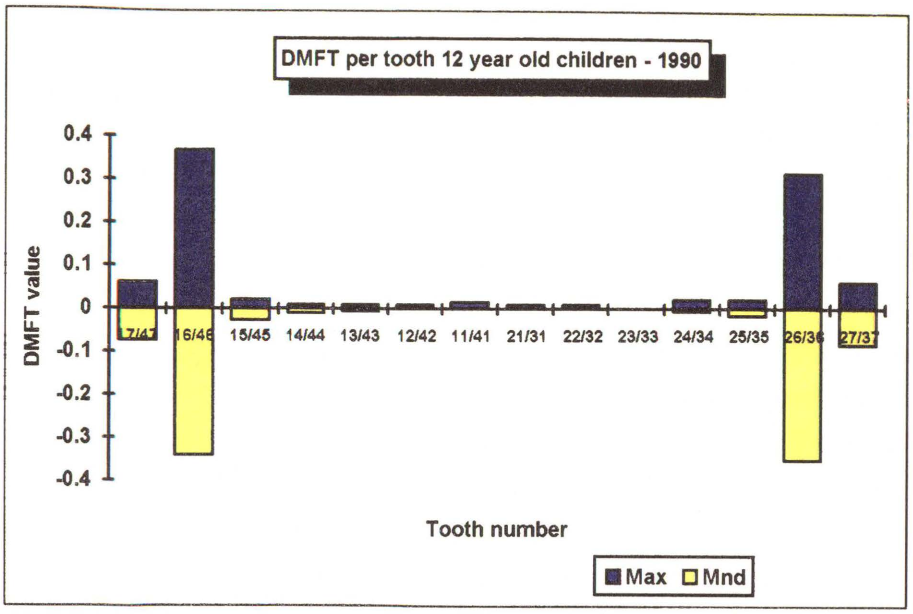

Figure 4.10: DMFT per tooth for the 12 year old children - 1990

From Figure 4.8 to Figure 4.10 it is clear that caries in this population is mainly a disease of the permanent molars. The molars contribute 84,97%, 85,71% and 89,64% to the total DMFT of the 6 year, 9 year and 12 year old groups respectively. Establishing the fact that molars contribute between 84% and 89% of the caries experience in the children population of the SADF, the exact distribution according to tooth surface is explored.

2.4.2.1.5. DMFS per surface per age

The DMFS per surface per age group is illustrated in Figure 4.11. Note the percentage contribution of the occlusal, buccal and lingual surfaces (pit and fissure surfaces) varying between 87% and 92% of the total DMFS.

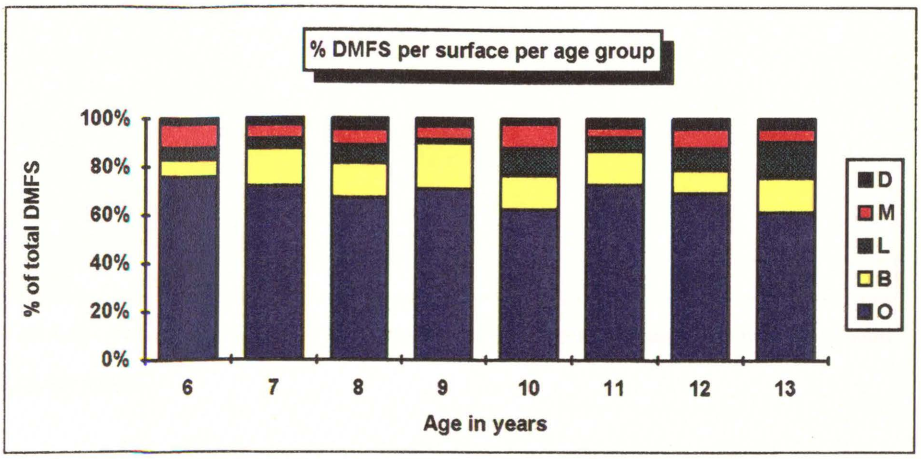

Figure 4.11: An illustration of the DMFS per tooth surface as a percentage of the total.

The process followed during 1990 as well as baseline epidemiological data recorded were discussed. The outputs generated by this process are subsequently deliberated.

2.4.2.2. Output

The intermediate output of the Preventive Project is discussed as: the schools visited, and number of children examined and treated; as well as the children examined, fissure sealants and referrals. This output is being defined as intermediate as the final output of the system is discussed in Chapter 5 under the evaluation of the Preventive System.

2.4.2.2.1. Schools visited, and number of children examined and treated

During 1990 the 17 schools listed in Table 4.13 were visited and the number of children examined and treated, as well as the number of hours spent at each school are indicated in Table 4.13.

School	Number of children	Number of hours
Bakenkop Laerskool	61	13
Booyens Laerskool	7	2
Derdepoort Laerskool	24	5
Elarduspark Laerskool	37	8
Erasmia Laerskool	48	10
Fleur Laerskool	48	10
Gen A Brink Laerskool	222	46
Hennopspark Laerskool	57	12
Hermanstad Laerskool	20	5
Louis Leipoldt Laerskool	60	13
Silverton Laerskool	17	4
Springvale Primary	28	6
Swartkop Laerskool	27	6
Tuinrand	18	4
Valhalla Laerskool	95	20
Valhalla Primary	85	18
Wierdapark Laerskool	60	13
Total	914	195

Table 4.13: The schools visited in 1990, the number of children examined and number of hours spent per school

2.4.2.2.2. Children examined, fissure sealants, and referrals

Table 4.14 presents the number of children per age group for the total study, the number of fissure sealants placed and the number of children referred to dental clinics for dental treatment.

Age group	Number of children	Number of fissure sealants	Number referred to dental clinics
6 years	169	257	124
7 years	227	472	187
8 years	70	120	59
9 years	50	12	21
10 years	27	39	14
11 years	124	146	74
12 years	193	242	128
13 years	54	89	38
TOTAL	914	1377	645

Table 4.14: Number of children examined, number of fissure sealants placed and number of children referred to dental clinics for treatment in 1990.

The intermediate output of the Preventive Project during 1990 was discussed. It is appropriate to give attention to the inputs needed to generate the output of the oral health system.

2.4.2.3. Input

The inputs as presented in Table 4.15 were calculated during the 1990 project (All costs are standardized at 1992 prices).

Item	Units consumed	Cost per unit	Total cost
Consumable items:			**2658.49**
Fissure Sealant (Chemical)	7 Boxes	149.92	1049.44
Fissure Sealant (UV)	3 Boxes	199.42	598.26
Hibiscrub	5 Bottles	3.35	16.75
Hibitane	40 Litres	14.06	562.40
Masks	145 Mask	0.3068	44.49
Gloves	535 Pairs	0.2134	114.17
Cotton roles	1950 Rolls	0.0165	32.18
Paper towels	1800 Towl	0.048	86.40
Suction Tips	450 Tips	0.13	58.50
Prophylactic paste	2 Bottles	32.35	64.70
Polishing Cups	24 Cups	1.30	31.20

Stationery:			**454.90**
Pencils	12 Pencils	0.20	2.40
Rubbers	6 Rubbers	0.45	2.70
Letters of consent	1100	0.12	132.00
Referral letters	645	0.12	77.40
Survey forms	930	0.12	111.60
Envelopes	920	0.14	128.80
Personnel:			**12385.65**
Project manager	250 Hours	35.37	8842.50
Dentists	390 Hours	5.68	2215.20
Assistants	195 Hours	6.81	1327.95
Oral hygiene students	195 Hours	0.00	0.00
Transport:			**1664.24**
Personnel	2400 Km	0.586	1406.40
Equipment	440 Km	0.586	257.84
Administrative:			**17.39**
Telephone	47 Calls	0,37	17.39
TOTAL			**17180.67**
COST PER CHILD	914 Children	18.796	**17180.67**
COST PER SEALANT	1377 F/S	12.476	**17180.67**

Table 4.15: Calculations of the inputs for the 1990 project.

The implementation during 1990 was deliberated in order of process, output and input. The implementation during 1991 is described next following the same framework.

2.4.3. Implementation during 1991

The project was implemented again according to the plan discussed in the first section of this chapter - a few alterations were made in order to make the project more flexible and adjustable. Follow-up children were firstly evaluated according to the criteria in Appendix H. All new children who became part of the programme were evaluated according to the criteria in Appendixes D, E, and F. The 1991 project thus consists of two components, namely:

1. The first follow up of the longitudinal study 1 (Longitudinal group 1)
2. A cross sectional study of the new children (Cross sectional group 2)

The implementation during 1991 is again described according to the guidelines of process, outputs and inputs.

2.4.3.1. Process

During 1991 only two dental teams visited the 17 primary schools. The process followed by each team was exactly the same as in 1990 (see Figure 4.5).

2.4.3.2. Output

2.4.3.2.1. Schools visited, and number of children examined and treated

During 1991 the 17 schools listed in Table 4.16 were visited and the number of children examined and treated, as well as the number of hours spent at every school are indicated in Table 4.16.

School	Number of children	Number of hours
Bakenkop Laerskool	75	7
Booyens Laerskool	9	1
Derdepoort Laerskool	29	3
Elarduspark Laerskool	45	4
Erasmia Laerskool	59	5
Fleur Laerskool	59	5
Gen A Brink Laerskool	273	23
Hennopspark Laerskool	70	6
Hermanstad Laerskool	25	2
Louis Leipoldt Laerskool	74	6
Lyttleton Primary	21	2
Silverton Laerskool	34	3
Swartkop Laerskool	33	3
Tuinrand	22	2
Valhalla Laerskool	117	10
Valhalla Primary	104	9
Wierdapark Laerskool	74	6
Total	1122	97

Table 4.16: Schools visited, number of children per school and hours spent at each school - 1991

2.4.3.2.2. Children examined, fissure sealants, and referrals

Table 4.17 presents the number of children per age group for the total study, the number of fissure sealants placed and the number of children referred to dental clinics for dental treatment.

Age group	Number of children	Number of fissure sealants	Number referred to dental clinics
6 years	174	230	110
7 years	242	280	149
8 years	223	188	102
9 years	62	64	36
10 years	14	15	6
11 years	143	121	63
12 years	223	142	69
13 years	41	59	26
TOTAL	1122	1099	561

Table 4.17: Number of children examined, number of fissure sealants placed and number of children referred to dental clinics for treatment in 1991.

2.4.3.3. *Input*

The inputs as presented in Table 4.18 were calculated during the 1991 project.

Item	Units consumed	Cost per unit	Total cost
Consumable items:			**2342.27**
Fissure Sealant (Chemical)	4 Boxes	149.92	599.68
Fissure Sealant (UV)	4 Boxes	199.42	797.68
Hibiscrub	3 Bottles	3.35	10.05
Hibitane	40 Litres	14.06	562.40
Masks	140 Mask	0.3068	42.95
Gloves	480 Pairs	0.2134	102.43
Cotton roles	1650 Rolls	0.0165	27.23
Paper towels	2000 Towels	0.048	96.00
Suction tips	420 Tips	0.13	54.60
Prophylactic paste	1 Bottle	32.35	32.35
Polishing cups	13 Cups	1.30	16.9
Stationery:			**422.92**
Pencils	6 Pencils	0.20	1.20
Rubbers	4 Rubbers	0.45	1.80
Letters of consent	1200	0.12	144.00
Referral letters	561	0.12	67.32
Survey forms	420	0.12	50.4
Envelopes	1130	0.14	158.20
Personnel:			**7177.60**
Project manager	150 Hours	35.37	5305.50
Dentists	97 Hours	5.68	550.96
Assistants	194 Hours	6.81	1321.14
Oral hygiene students	97 Hours	0.00	0.00

Transport:			**937.60**
Personnel	1220 Km	0.586	714.92
Equipment	380 Km	0.586	222.68
Administrative:			**8.14**
Telephone	22 Calls	0.37	8.14
TOTAL			**10888.53**
COST PER CHILD	1122 Children	**9.70**	**10888.53**
COST PER SEALANT	1099 Sealants	**9.91**	**10888.53**

Table 4.18: The inputs for the project during 1991 - number of units used, cost per unit and total cost

The final implementation during 1992 is subsequently discussed.

2.4.4. Implementation during 1992

The project was again implemented according to the plan discussed in the first section of this chapter - more alterations were made in order to make the project more flexible and adjustable. Follow-up children (second and first year) were firstly evaluated according to the criteria in Appendix H. All new children who became part of the programme were evaluated according to the criteria in Appendixes D, E, and F. The 1992 project thus consists of three components, namely:

1. The second follow up of longitudinal group 1 (Longitudinal group 1)
1. The first follow up of longitudinal group 2 (Longitudinal group 2)
2. A cross sectional study of the new children (Cross sectional group 3)

The implementation during 1992 is discussed according to the framework: process, outputs and inputs.

2.4.4.1. Process

During 1992 only two dental teams visited 11 primary schools. The process followed by each team was exactly the same as in 1990 (see Figure 4.5). Six primary schools were eliminated due to the decline in the number of attending SADF children (If a school had less than 20 children it was calculated to be not efficient to visit that school).

2.4.4.2. Output

2.4.4.2.1. Schools visited, and number of children examined and treated

During 1992 only 11 schools listed in Table 4.19 were visited and the number of children examined and treated, as well as the number of hours spent at each school are indicated in Table 4.19. The six schools that were eliminated from the study showed a vast decline in the number of attending SADF children making it inefficient to visit those schools.

School	Number of children	Number of hours
Bakenkop Laerskool	103	11
Elarduspark Laerskool	63	7
Erasmia Laerskool	83	9
Fleur Laerskool	79	9
Gen A Brink Laerskool	376	40
Hennopspark Laerskool	97	10
Louis Leipoldt Laerskool	102	11
Swartkop Laerskool	46	5
Valhalla Laerskool	161	17
Valhalla Primary	144	15
Wierdapark Laerskool	102	11
Total	1356	145

Table 4.19: Schools visited, number of children per school and hours spent at each school - 1992

2.4.4.2.2. Children examined, fissure sealants, and referrals

Table 4.20 presents the number of children per age group for the total study, the number of fissure sealants placed and the number of children referred to dental clinics for dental treatment.

Age group	Number of children	Number of fissure sealants	Number referred to dental clinics
6 years	141	246	85
7 years	197	385	128
8 years	212	235	116
9 years	219	222	111
10 years	207	251	99
11 years	167	174	69
12 years	157	151	63
13 years	56	74	24
TOTAL	1356	1738	695

Table 4.20: Number of children examined, number of fissure sealants placed and number of children referred to dental clinics for treatment in 1992.

2.4.4.3. *Input*

The inputs as presented in Table 4.21 were calculated during the 1992 project.

Item	Units consumed	Cost per unit	Total cost
Consumable items:			**3124.67**
Fissure Sealant (UV)	10 Boxes	199.42	1994.20
Hibiscrub	4 Bottles	3.35	13.40
Hibitane	45 Litres	14.06	632.70
Masks	190 Mask	0.3068	58.29
Gloves	640 Pairs	0.2134	136.58
Cotton roles	2300 Rolls	0.0165	37.95
Paper towels	2400 Towels	0.048	115.20
Suction tips	630 Tips	0.13	81.9
Prophylactic paste	1 Bottle	32.35	32.35
Polishing cups	17 Cups	1.30	22.10
Stationery:			**551.72**
Pencils	6 Pencils	0.20	1.20
Rubbers	4 Rubbers	0.45	1.80
Letters of consent	1400	0.12	168.00
Referral letters	695	0.12	83.4
Survey forms	450	0.12	54
Envelopes	1738	0.14	243.32
Personnel:			**8457.70**
Project manager	160 Hours	35.37	5659.20
Dentists	145 Hours	5.68	823.60
Assistants	290 Hours	6.81	1974.90
Oral hygiene students	145 Hours	0.00	0.00
Transport:			**738.36**
Personnel	950 Km	0.586	556.70
Equipment	310 Km	0.586	181.66
Administrative:			**5.92**
Telephone	16 Calls	0.37	5.92
TOTAL			**12878.37**
COST PER CHILD	1356 Children	9.497	**12878.37**
COST PER SEALANT	1738 Sealants	7.409	**12878.37**

Table 4.21: The inputs for the project during 1992 - number of units used, cost per unit and total cost

The implementation during 1992 was deliberated following the structure of process, outputs and inputs. This was the final year of implementation for the purpose of this study. The Preventive Project was however again implemented, with minor adjustments during 1993.

3. Summary

Chapter 4 gave attention to the implementation of the first action to improve the situation in the Oral Health Service of the SAMS, namely the planning, development and implementation of a Preventive Project. The planning, development and implementation of the Preventive Project were discussed according to a framework suggested by Kerzner (1992, p 82). The theoretical framework of Kerzner was firstly discussed, whereafter the conceptual and planning phase, the definition and design phase, and finally the implementation phase during 1990, 1991 and 1992 were deliberated. The implementation during each year was discussed following the systems phenomena of process, output and input. The evaluation of the Preventive Project (System) is deliberated in Chapter 5.

CHAPTER 5

EVALUATION OF THE PREVENTIVE SYSTEM (PROJECT)

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CHAPTER 5

EVALUATION OF THE PREVENTIVE SYSTEM (PROJECT)

1. Introduction

The planning, development and implementation of the Preventive Project (system) were deliberated in Chapter 4. Chapter 5 gives consideration to the evaluation of the Preventive Project. The evaluation of the Preventive Project is divided into three major aspects, namely: [1] Impact evaluation; [2] Process evaluation; and [3] Evaluating the planning and management of the Preventive Project. The evaluation of the impact of the Preventive System (project) is firstly discussed.

The framework of Chapter 5 as well as its orientation in the dissertation is illustrated in Figure 5.1.

2. Impact evaluation

The impact of the Preventive Project is evaluated in two steps. In the first step the fissure sealants *per se* are evaluated according to the dental literature. Secondly a systems approach is utilized to evaluate the Preventive System more comprehensively, wholistic or closer to the real world situation. The evaluation of the fissure sealants as a modality is subsequently discussed.

2.1. Fissure sealants as a modality

The evaluation of fissure sealants according to the literature is reviewed in detail in Appendix B. The reason for the evaluation of the sealants *per se* according to the dental literature is to come to a conclusion concerning the usability and effectiveness of so-called state of the art scientific evaluation methods in health delivery organizations.

According to Ripa (1980, p 127; 1983, p 216), Gwinnett (1982, p 298) and Silverstone (1983, p 44) the safety and efficacy of fissure sealants are clearly indicated. This study thus intended to evaluate only the effectiveness and the efficiency of fissure sealants in the children population of the SADF. The effectiveness is discussed next.

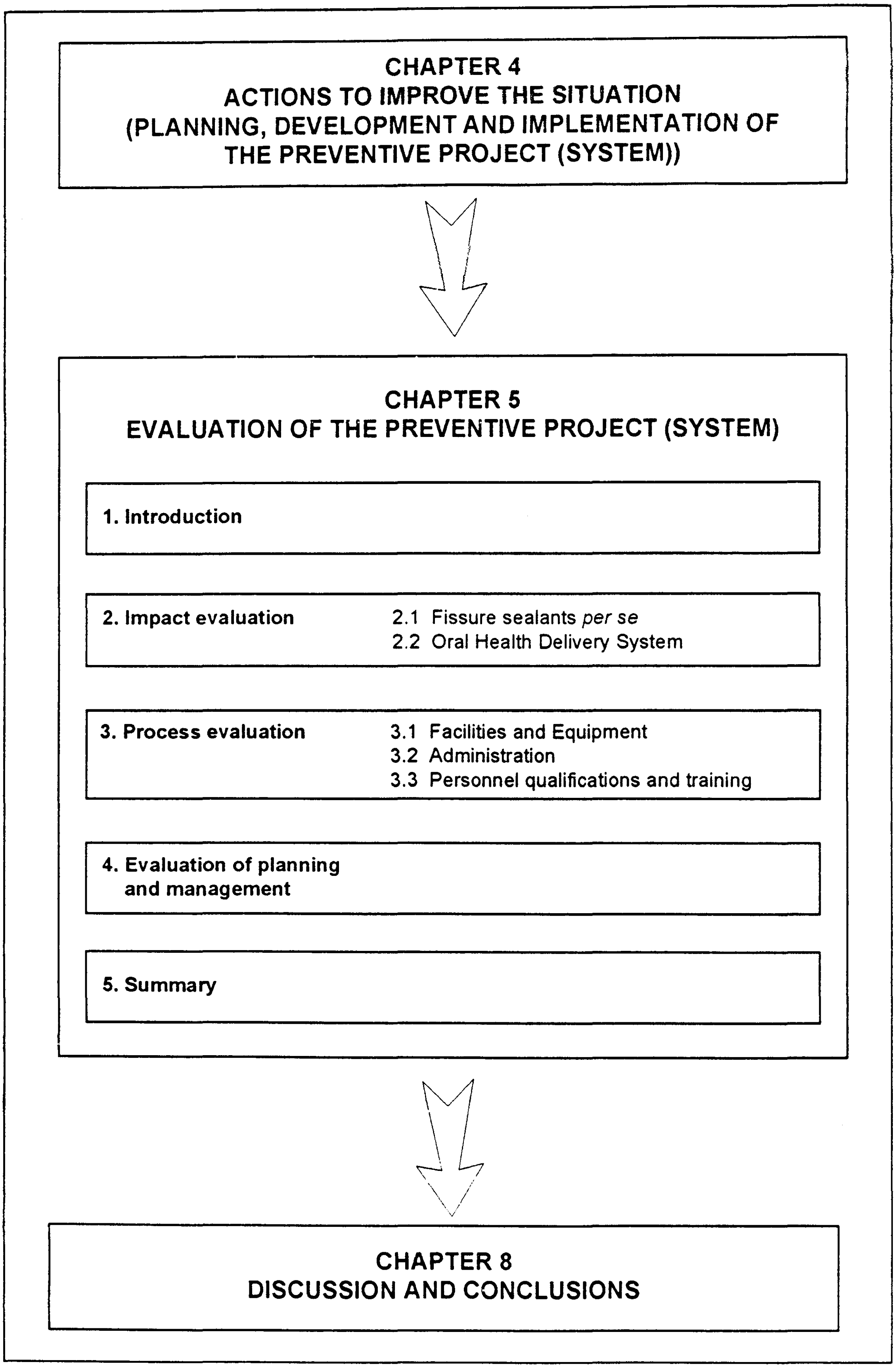

Figure 5.1: The conceptual framework for and the orientation of Chapter 5 within the dissertation.

2.1.1. Effectiveness

The effectiveness of the fissure sealants is evaluated according to five criteria (advocated by dental literature - see Appendix B), namely: [1] Clinical retention; [2] Occlusal caries reduction; [3] Caries status of sealed teeth; [4] Re-application rates; and [5] Reduction of caries risk.

2.1.1.1. Clinical retention

According to Ripa (1985, p 370) sealants have no active ingredients and the prevention of tooth decay is solely achieved by the bonding of the sealant to the enamel surfaces and the physical isolation of the pits and fissures from the rest of the oral environment. The longevity of a sealant is thus the prime determinant of sealant success. Mertz-Fairhurst (1984, p 18) and Rock (1984, p 27) even indicated that caries inhibition is a direct function of sealant retention.

The clinical retention of the fissure sealants in the Preventive Project of the SAMS were evaluated in 1991 and 1992. The fissure sealants done in the preceding years were evaluated according to the criteria in Appendix H. The clinical retention of fissure sealants in the Preventive System is described for the total population.

2.1.1.1.1. Total population

The clinical retention is stated one and two years after sealant application (Table 5.1).

	After 1 year		After 2 years	
	Count	%	Count	%
Number of children	364		192	
Complete Retention	370	92.50	356	75.26
Partial Retention	25	6.25	103	21.78
Lost	5	1.25	14	2.96
TOTAL	400	100.00	157	100.00

Table 5.1: Clinical retention of fissure sealants after one and two years, placed when children were 6 years old.

These results compare favourably with studies reported in the literature (see Appendix B). Taking into account the fact that most of the reported studies were completed in favourable clinical situations, the clinical retention in this real world field study performed among the top studies in the world.

2.1.1.2. Occlusal caries reduction

Studies reported by Ripa (1985, p 370) evaluated occlusal caries reduction by doing split mouth studies (see Appendix B). The studies are however no longer justified, and therefore Heidmann, Poulsen and Mathiassen (1990, p 387) evaluated occlusal caries reduction by calculating the reduction in caries prevalence in a longitudinal study. In the Preventive Project of the SAMS the occlusal caries reduction was also evaluated according to the reduction in caries prevalence one and two years after application of the sealant.

The children aged 7 in 1990 were used as a longitudinal group as they were the group with the lowest attrition in number of children. This group was followed up in 1991 and 1992. The longitudinal follow-up was evaluated against the baseline data gathered in 1990 for 7, 8 and 9 year old children. The DMFT of the longitudinal follow-up group is compared with the baseline DMFT in Table 5.2.

	7 years		**8 years**		**9 years**	
	N	**DMFT**	**N**	**DMFT**	**N**	**DMFT**
Longitudinal Group	227	0.264	156	0.321	94	0.351
Baseline 1990	227	0.264	70	0.643	50	0.840
DMFT Reduction	0.000		0.322		0.489	
% Caries Reduction	0.000		50.07		58.21	

Table 5.2: Real and percentage caries reduction after 1 and 2 years.

If effectiveness is evaluated according to percentage caries reduction, then the fissure sealants were 50,07% and 58,21% effective after one and two years respectively. These figures might however be confounded by the presence of dental caries at the age of 7. If the data in Table 5.2 were adjusted to accommodate the "confounding DMFT" of 0,264, the effectiveness actually increases to 84 percent. In comparison with the study of Heidmann, Poulsen and Mathiassen (1990, p 387) this study compares highly effective.

2.1.1.3. *Caries status of sealed teeth*

Weintraub (1989, 326) reviewed fissure sealant studies on effectiveness that evaluated the effectiveness of the sealants due to the percentage of sealed teeth becoming carious or restored at yearly intervals after initial placement. This percentage represents the "failure" rate. If this "failure" rate is subtracted from 100% a "success" rate is calculated. Table 5.3 presents the number of sealed teeth becoming carious or restored, the percentage of sealed teeth becoming carious or restored, and the "success" rate one and two years after application respectively in the Preventive System of the SAMS.

	1 Year	2 Years
Population size (N)	364	192
Number of teeth carious or restored	2	4
% of teeth carious or restored	0.5	0.85
"Success" rate	99.5	99.15

Table 5.3: Percentage of teeth becoming carious one and two years after initial placement.

According to the studies reported by Weintraub (1989, p 326) the evaluation of this project according to this effectiveness criterion is above the average. It is not known however whether the sealed teeth would have become carious at all if they were not sealed.

2.1.1.4. *Re-application rates*

The evaluation of re-application rates as an indication of sealant effectiveness is proposed by Whyte *et al* (1987, p 177) and Weintraub (1989, p 319) (see Appendix B). The re-application rates after one and two years respectively for this study presented in Table 5.4.

	1 Year	2 Years
Population size (N)	364	192
Number of teeth re-sealed	3	10
% of teeth re-sealed	0.75	2.11

Table 5.4: The number and percentage of teeth resealed one and two years after initial placement.

In comparison with the studies of Whyte *et al* (1987, p 177) and Weintraub (1989, p 319) the percentage of teeth re-sealed (re-application rate) in the sealant project of the SAMS is very low. If effectiveness was to be assessed according to this criterion the sealant project of the SAMS was highly effective.

2.1.1.5. Reduction of caries risk

Simonsen (1987, p 33 and 1991, p 39) proposed the use of the Odds ratio to determine the risk of a sealed tooth becoming carious compared to a non-sealed tooth. The study of the SAMS was not a combined-paired study and the Odds ratio cannot be used to make the same analysis. The relative risk and attributable risk can however be calculated (Dept Community Health, 1990, Unpublished). These ratios are firstly calculated for individuals and then the relative risk and attributable risk are calculated on a tooth level.

2.1.1.5.1. Relative risk and Attributable risk for individuals

The four-by-four table in Figure 5.2 was compiled for 9 year old children in 1992 to calculate the relative risk and attributable risk for individuals due to the absence of fissure sealants.

	Indiv with caries	Indiv without caries	
Individuals with fissure sealants	20	74	94
Individuals without fissure sealants	19	31	50
	39	105	144

Figure 5.2: The four-by-four table to calculate the relative risk and attributable risk in 9-year old children due to the absence of fissure sealants.

Relative risk = 20(19+31)/19(20+74)
= 1000/1786
= 0,5599
or = 1:1,786

The risk for an individual without fissure sealants to develop dental caries is thus 1,786 times larger as compared to an individual with fissure sealants.

Attributable risk	=	0,653(-0,44)/(0,653(-0,44)+1)
	=	-0,2874/0,7126
	=	-0,4033

It can thus be concluded from the attributable risk that if the fissure sealant project was not implemented the number of children suffering from decay would probably have been 40 percent more.

2.1.1.5.2. Relative risk and Attributable risk for teeth

The four-by-four table in Figure 5.3 was compiled for all the teeth of 9 year old children in 1992 to calculate the relative risk and attributable risk for teeth due to the absence of fissure sealants.

	Teeth with caries	Teeth without caries	
Teeth of individuals with fissure sealants	33	2223	2256
Teeth of individuals without fissure sealants	42	1158	1200
	75	3381	3456

Figure 5.3: The four-by-four table to calculate the relative risk and attributable risk for teeth in 9-year old children due to the absence of fissure sealants.

Relative risk	=	33(42+1158)/42(33+2223)
	=	39600/94752
	=	0,4179
or	=	1:2,392

The risk for a tooth of an individual without fissure sealants to develop dental caries is thus 2,392 times larger as compared to a tooth of an individual with fissure sealants.

Attributable risk = 0,653(-0,5821)/(0,653(-0,5821)+1)
= -0,3801/0,6198
= -0,6133

It can thus be concluded from the attributable risk that if the fissure sealant project was not implemented the number of teeth getting decayed would probably have been 61 percent more.

2.1.1.6. Effectiveness conclusion

Table 5.5 presents a summary of the effectiveness of the fissure sealants *per se* evaluated according to the evaluation criteria promoted in recent dental literature.

		Effectiveness (%)	
	Effectiveness criterion	**After One Year**	**After Two Years**
1.	Clinical retention (Complete + Partial)	97,75	97,04
2.	Caries reduction	50,07	58,21
3.	Caries status of sealed teeth	99,50	99,15
4.	Re-application rates	0,75	2,11
5.	Reduction of caries risk	-	-61,33

Table 5.5: A summary of the effectiveness of the fissure sealants *per se* evaluated according to the dental literature

The only two evaluation techniques making sense in a limited resources health services organization are the percentage caries reduction and the percentage reduction of caries risk.

2.1.2. Efficiency

The efficiency of sealants is evaluated according to the three measures posed by the dental literature, namely: [1] Cost-effectiveness; [2] Benefit-to-effort ratio; and [3] Cost benefit analysis.

2.1.2.1. Cost-effectiveness

Ball (1986, p 383), Ripa (1985, p 374), Horowitz (1980, p 118) and Eklund (1986, p 136) calculated the cost-effectiveness of fissure sealants by calculating the cost involved in the placement of fissure sealants. A number of factors were identified that influence the so-called cost-effectiveness of fissure sealants (see Appendix B). These early calculations were probably based on the fact that effectiveness was mainly evaluated as the clinical retention of the sealant. As indicated above this is not true for a limited resources service organization. Elderton (1990, p 250) was the first to acknowledge the fact that sealants applied to teeth that would not become carious, have a negative effect on cost-effectiveness.

This evaluation attempts to calculate the cost of a single sealant applied by a dentist with an assistant as well as by an oral hygienist with an assistant. It however goes further and evaluates the cost of the sealants in comparison with the oral health effect it had.

2.1.2.1.1. Cost of fissure sealants

The cost of fissure sealants is calculated in Table 5.6 from the information presented in Tables 4.15, 4.18 and 4.21 in Chapter 4.

	1990	1991	1992	Total/ Average
Number of sealants	1377	1099	1738	4214
Cost: Consumables	2658,49	2342,27	3124,67	8125,43
Consumable cost/sealant	1,93	2,13	1,79	1,93
Personnel:				
Dentist	1107,60			
Hygienist		0,00	0,00	
Personnel cost per sealant	0,80	0,00	0,00	
Total cost per sealant	2,73	2,13	1,79	2,22

Table 5.6: Calculation of the cost per sealant in 1990, 1991 and 1992

Table 5.6 indicated that the average cost per sealant applied over the three year period from 1990 to 1992 (according to 1992 prices) was R2.22. The lower cost occurring in 1992 (R1.79 per sealant) was the result of: [1] The use of oral hygienists instead of dentists; [2] The more efficient use of consumable items; and [3] The optimal use of fixed costs (infrastructure).

Although Table 5.6 indicated the real personnel cost during implementation, it might be unrealistic due to the facts that the dentists used during 1990 were National servicemen (salaries about 20% of full time dentists) and the oral hygiene students did not receive any compensation. If the two aspects are adjusted to a more realistic situation the calculations in Table 5.6 will change as illustrated in Table 5.7.

	1990	1991	1992	Total/ Average
Number of sealants	1377	1099	1738	4214
Cost: Consumables	2658,49	2342,27	3124,67	8125,43
Consumable cost/sealant	1,93	2,13	1,79	1,93
Personnel:				
Dentist	5909,28			
Hygienist		1653,85	2472,25	
Personnel cost per sealant	4,29	1,50	1,42	
Total cost per sealant	6,22	3,63	3,21	4,35

Table 5.7: Calculation of the cost per sealant in 1990, 1991 and 1992 with realistic personnel adjustments

From Table 5.7 it is clear that sealants done by dentists cost more than R6.00 per sealant, while sealants applied by oral hygienists cost between R3.20 and R3.70 according to 1992 prices and salaries.

It was calculated that the cost of a one surface amalgam was, according to 1992 prices and salaries, approximately R15.00. It can thus be concluded that the cost of one sealant presents 23 percent of the cost of one amalgam.

2.1.2.1.2. Oral health improvement cost

In order to make cost-effectiveness calculations more realistic the cost of fissure sealants should be associated with the improvement in oral health due to the application of fissure sealants. In order to do these calculations the information presented in Table 5.2 (page 128) was used.

Table 5.8 presents the cost per unit DMFT reduction due to sealant application from age 7 to 9.

Age	7	8	9
Number of children	227	156	50
Baseline DMFT	0,264	0,643	0,840
DMFT at follow up	0,264	0,321	0,351
Reduction in DMFT	0,000	0,322	0,489
Number of sealants	472	13	1
Cost per sealant (R)	3,45	3,45	3,45
Total sealant cost (R)	1628,40	44,85	3,45
Accumulated cost (R)	1628,40	1673,25	1676,70
Accumulated cost/mouth (R)	7,17	7,37	7,39
Cost/Unit DMFT reduction (R)	------	22,26	15,07

Table 5.8: Calculation of the real cost per unit DMFT reduction one and two years after application.

According to the calculation in Table 5.8 the cost per unit of DMFT reduction in the children population of the SADF was R22,26 one year after sealant application. If this amount is compared with the cost of a single one surface amalgam (R15.00) the sealing of molars to prevent pit and fissure caries in this population seems inefficient. However, after two years the cost per unit of DMFT reduced declined to R15.07.

Table 5.9 attempts to project the cost per unit of DMFT reduction in the 13 year old children of the SADF. The resulting cost per DMFT unit of R9.44 is promising and will probably, according to Simonsen (1991, p 41), decline more up to the age of 18. Figure 5.4 illustrates the cost per unit of DMFT reduction per age group in the children population of the SADF.

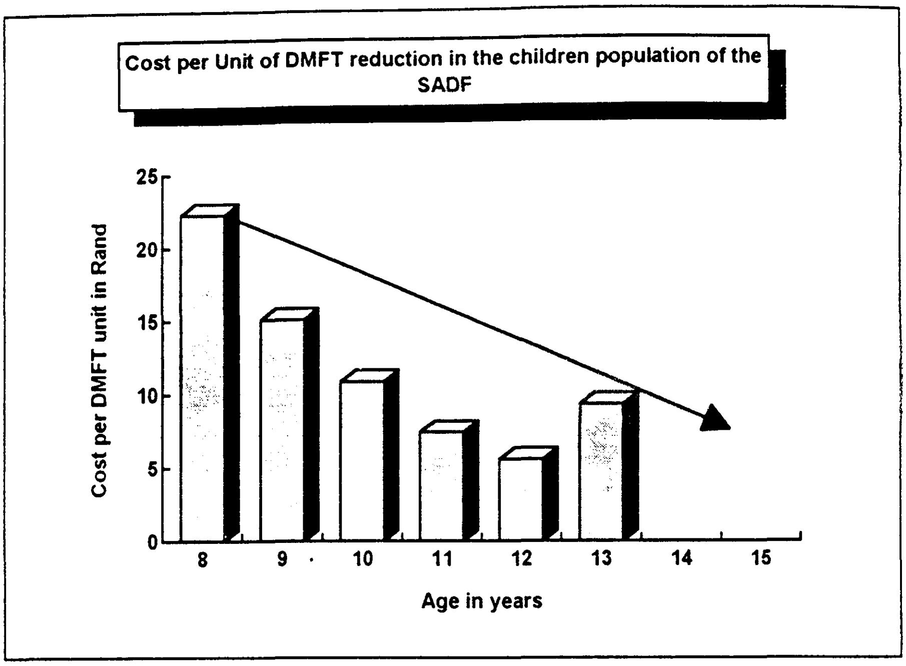

Figure 5.4: An illustration of the cost per unit of DMFT reduction after a first sealant application at the age of 7.

2.1.2.2. *Benefit-to-effort ratio*

According to the dental literature this ratio indicates the number of sealants needed to prevent one amalgam filling. Simonsen (1991, p 41) concluded that if only at risk teeth could be sealed this ratio would be close to 1:1. This clearly indicates the need for sensitive selection criteria. Table 5.10 illustrates the benefit-to-effort ratio of this sealant project in the children population of the SADF.

Age	7	8	9
Number of children	227	227	227
Baseline DMFT	0,264	0,643	0,840
DMFT at follow-up	0,264	0,321	0,351
Reduction in DMFT	0,000	0,322	0,489
Number of sealants	472	13	1
Number of sealants for reduction	0	472	485
Number of sealants / mouth for Reduc	0	2,08	2,14
Benefit-to-effort ratio		1:6,46	1:4,37

Table 5.10: Calculation of the benefit-to-effort ratio one and two years after application.

The calculations in Table 5.10 indicated a benefit-to-effort ratio in this study of 1:6,46 after one year and 1:4,43 after two years. Table 5.11 (page 131)

Table to project the probable cost per unit DMFT reduction from the age of 7 to 13 in the children population of the SAD							
Age	7	8	9	10	11	12	13
Number of children	227.00	227.00	227.00	227.00	227.00	227.00	227.00
Baseline DMFT	0.26	0.64	0.84	1.07	1.45	1.85	2.11
DMFT at follow up	0.26	0.32	0.35	0.39	0.44	0.48	0.53
Reduction in DMFT	0.00	0.32	0.49	0.68	1.01	1.37	1.59
Number of sealants	472.00	13.00	1.00	7.00	7.00	472.00	13.00
Cost per sealant in Rand	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Total cost in Rand	1628.40	44.85	3.45	24.15	24.15	1628.40	44.85
Accumulated reduction cost in Rand	0.00	1628.40	1673.25	1676.70	1700.85	1725.00	3353.40
Acc. reduction cost per mouth in Rand	0.00	7.17	7.37	7.39	7.49	7.60	14.77
Cost/Unit DMFT reduction in Rand		22.28	15.07	10.87	7.40	5.55	9.31
All prices are standardized at 1992							

Table 5 9 Calculation of the cost per unit of DMFT reduction as well as a possible projection of the trend

Table to project the probable benefit-to-effort ratio from the age of 7 to 13 in the children population of the SADF							
Age	7	8	9	10	11	12	13
Number of children	227.00	227.00	227.00	227.00	227.00	227.00	227.00
Baseline DMFT	0.26	0.64	0.84	1.07	1.45	1.85	2.11
DMFT at follow up	0.26	0.32	0.35	0.39	0.44	0.48	0.53
Reduction in DMFT	0.00	0.32	0.49	0.68	1.01	1.37	1.59
Number of sealants	472.00	13.00	1.00	7.00	7.00	472.00	13.00
Number of sealants for reduction	0.00	472.00	485.00	486.00	493.00	500.00	972.00
Number of sealants for red. per mouth	0.00	2.08	2.14	2.14	2.17	2.20	4.28
Benefit-to-effort Ratio	1:0,0	1:6,46	1:4,37	1:3,15	1:2,14	1:1,61	1:2,70

Table 5 11 Calculation of the benefit-to-effort ratio as well as a probable projection of the trend attempts to make a future projection of this declining trend. Figure 5.5 illustrates the benefit-to-effort ratio of fissure sealants in the children population of the SADF. Note that the ratio tends to a 1:1 relationship.

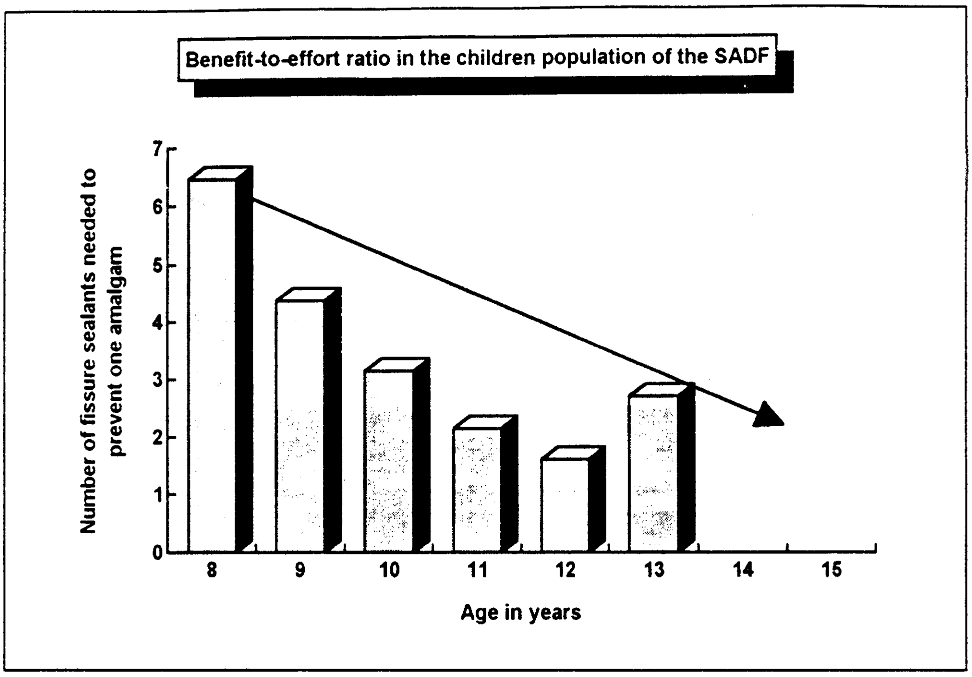

Figure 5.5: An illustration of the benefit-to-effort ratio after a first sealant application at the age of 7.

2.1.2.3. Cost-benefit analysis

According to Ripa (1985, p 375) it is difficult to account for the many intangible benefits of a sealant programme (see Appendix B). This study acknowledges the intangible benefits on a higher or systems level.

The efficiency of the fissure sealants *per se* have been evaluated according to the measures of cost-effectiveness, benefit-to-effort ratio and cost-benefit analysis. Cost-effectiveness according to the cost to improve oral health and the benefit-to-effort ratio seems to make sense for the health industry. It is however evaluating efficiency in relative isolation. It is therefore necessary to give attention to a wider, more open concept, namely to evaluate the Preventive System from a systems perspective.

2.2. Preventive System (project)

The Preventive System (project) is evaluated in accordance with the following framework: [1] Efficacy of the system; [2] Availability and Accessibility; [3] Acceptability; [4] Efficiency; [5] Effectiveness; [6] Cost-effectiveness; and [7] Net contribution.

2.2.1. Efficacy

The efficacy of the Preventive System depended on management and planning of the project, the availability of resources, the opportunity to visit primary schools and ability for the fissure sealants *per se* to be effective and efficient. According to these criteria the efficacy of the Preventive System was evaluated to be highly positive.

2.2.2. Availability and Accessibility

The Preventive System increased the availability and accessibility of oral health care from approximately 50 to 80 percent of the primary school children of the SADF. About 20 percent of SADF children did not partake in the direct advantages of the Preventive System. These children were distributed in numbers of less than 20 per primary school. If these schools were visited the average cost per sealant and per child would have increased by at least 50 percent, making the project inefficient. These children were however invited and encouraged to visit their nearest dental clinic where they would receive the same preventive service. It is concluded that the availability and accessibility of the Preventive System were more than 80 percent.

2.2.3. Acceptability

The acceptability of the Preventive Project was evaluated by a questionnaire given to all the different groups of individuals involved in the total Preventive System. Two questions were asked in order to determine acceptability.

2.2.3.1. Question 1: Were you satisfied with the service rendered?

Table 5.12 presents the response by the different groups on this question.

Group	Yes (% of total)	No (% of total)	Uncertain (% of total)
Children	91,18	6,86	1,96
Parents	96,24	1,50	2,26
Primary Schools	100,00	0,00	0,00
Dental staff officers	100,00	0,00	0,00
Field team personnel	72,22	5,56	22,22

Table 5.12: Response of different individuals involved in the Preventive Project on the question whether they were satisfied with the service rendered.

The results presented in Table 5.12 clearly indicated the satisfaction of the different groups involved in the Preventive Project. The only group differing significantly from the rest was the field team personnel. The 22,22 percent of this group indicating uncertainty on this question suggested that the equipment was too primitive or they felt that the children could have been transported to dental clinics where the situation was ideal. This 22,22 percent was thus biased by personal preferences.

2.2.3.2. Question 2: Do you think that the oral health programme should continue in future?

Table 5.13 presents the response by the different groups on this question.

Group	Yes (% of total)	No (% of total)	Uncertain (% of total)
Children	94,12	5,88	0,00
Parents	98,50	1,50	0,00
Primary Schools	100,00	0,00	0,00
Dental staff officers	100,00	0,00	0,00
Field team personnel	94,44	0,00	5,56

Table 5.13: Response of different individuals involved in the Preventive Project on the question whether they think that the programme should continue in future

The results presented in Table 5.13 clearly denote the acceptability of the Preventive Project by the different groups involved.

According to Table 5.12 and Table 5.13 it was concluded that the acceptability of the oral health programme by all the groups concerned was between 90 and 100 percent.

2.2.4. Efficiency

Efficiency from a systems perspective is a wider concept than generally used in management and especially dental literature (see Appendix A). According to Hitchins (1992, p 89) no system is isolated. A system receives inputs from one or more systems "upstream" and it produces outputs that forms the input to one or more systems "downstream". Figure 5.6 illustrates this input-output relationship between systems "upstream" and "downstream".

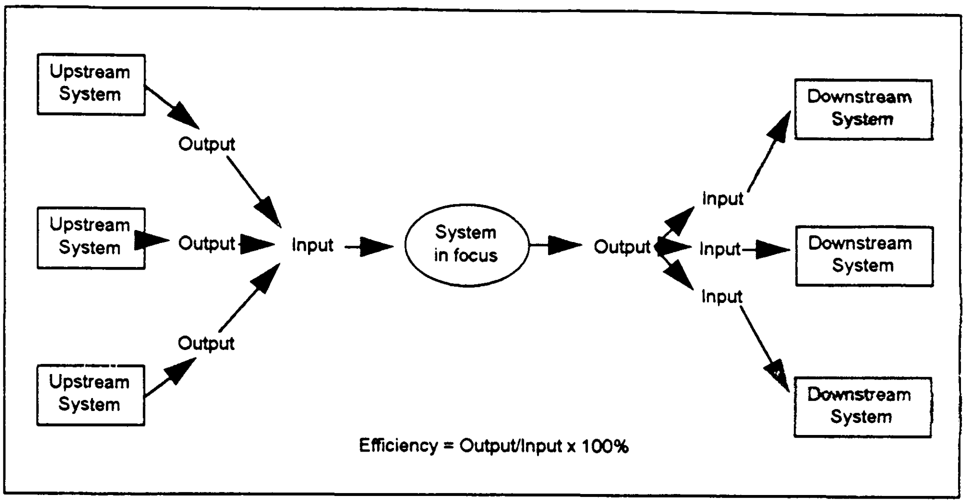

Figure 5.6: Efficiency from a systems view.

The following deliberation attempts to evaluate the efficiency of the Preventive Project from a systems viewpoint. The inputs are firstly determined, then the outputs are quantified and finally the efficiency ratio is calculated.

2.2.4.1. *Defining the inputs*

The total inputs needed to manage, implement and complete the Preventive Project were calculated in Chapter 4, Tables 4.15, 4.18 and 4.21. Table 5.14 presents a summary of the total inputs required during 1990, 1991 and 1992.

Item	**1990**	**1991**	**1992**
Consumable Items	2658,49	2342,27	3124,67
Stationery	454,90	422,92	551,72
Personnel	12385,65	7177,60	8457,70
Transport	1664,24	937,60	738,36
Administrative	17,39	8,14	5,92
TOTAL COST	17180,67	10888,53	12878,37
Cost per child	18,79	9,70	9,49
Cost per 1000 children	18790,00	9700,00	9490,00
Cost per sealant	12,47	9,91	7,40

Table 5.14: Calculation of the total inputs of the Preventive System in monetary terms at 1992 prices

The decline in cost per child and cost per sealant was the result of better planning, the use of oral hygienists instead of dentists and the more efficient use of materials. It is accepted that the results presented for 1992 are reproducible if a preventive system (project) is managed properly, and the calculations herefrom will use these figures.

2.2.4.2. Defining the outputs

The different quantifiable outputs are presented in Table 5.15.

	After one year		After two years	
		Cost		**Cost**
Health promotion:				
DMFT Reduction	0,322		0,489	
Fillings saved/1000 child	322,0		489,0	
At R15,00 per filling		4830,00		7335,0
School time for children				
Number fillings saved	322,0		489,0	
57% AM appointments	184,0		279,0	
Absence time/appointm	90 min		90 min	
Total time saved	16519 min		25110 min	
	275 hours		419 hours	
At average GDP/capita /hour	R 3,60	991,12	R 3,60	1505,14
Work time for parents				
Number fillings saved	322,0		489,0	
43% accompanied by parents	138,0		211,0	
Worker absence time per appointment	120 min		120 min	
Total absence time	16615 min		25320 min	
	277 hours		422 hours	
At average Income/Hour	R 22,00	6092,24	R 22,00	9251,88
TOTAL		**11 913,36**		**18 092,02**

Table 5.15: Calculation of the output value in rand at 1992 prices for the Preventive System

2.2.4.3. Comparing outputs and inputs (System efficiency)

The final step in determining the efficiency of a system is to apply the formula: Efficiency = Output/Input x 100%. The efficiency level of the Preventive System one and two years after implementation are presented in Table 5.16.

	After one year	After two years
Output in Rand	11 913,36	18 092,02
Input in Rand	9 490,00	9 490,00
Efficiency %	**126 %**	**191 %**

Table 5.16: Calculation of the efficiency of the Preventive Project after one and two years.

	After 1 year		After 2 years		After 3 years		After 4 years		After 5 years	
		Cost		Cost		Cost		Cost		Cost
Health Promotion										
DMFT Reduction	0.32		0.49		0.68		1.01		1.37	
Fillings saved/1000	322.00		489.00		679.50		1013.00		1368.50	
Cost per filling	15.00		15.00		15.00		15.00		15.00	
HEALTH PROMOTION SAVING		**4830.00**		**7335.00**		**10192.50**		**15195.00**		**20527.50**
School time saved										
Fillings saved/1000	322.00		489.00		679.50		1013.00		1368.50	
57% AM appointments	183.54		278.73		387.32		577.41		780.05	
Absence time / appointment	90.00		90.00		90.00		90.00		90.00	
Total time saved in minutes	16518.60		25085.70		34858.35		51966.90		70204.05	
Total time saved in hours	275.31		418.10		580.97		866.12		1170.07	
At average GDP/capita/hour	3.60		3.60		3.60		3.60		3.60	
SCHOOL TIME COST SAVED		**991.12**		**1505.14**		**2091.50**		**3118.01**		**4212.24**
Work time for parents saved										
Fillings saved/1000	322.00		489.00		679.50		1013.00		1368.50	
43% accompanied by parents	138.46		210.27		292.19		435.59		588.46	
Worker absence time/appointment (min	120.00		120.00		120.00		120.00		120.00	
Total absence time saved (minutes)	16615.20		25232.40		35062.20		52270.80		70614.60	
Total absence time saved (hours)	276.92		420.54		584.37		871.18		1176.91	
At average income per hour	22.00		22.00		22.00		22.00		22.00	
WORK TIME COST SAVED		**6092.24**		**9251.88**		**12856.14**		**19165.96**		**25892.02**
TOTAL SAVING (OUTPUT)		**11913.36**		**18092.02**		**25140.14**		**37478.97**		**50631.76**
INPUT COSTS		**9490.00**		**9490.00**		**9490.00**		**9490.00**		**9490.00**
EFFICIENCY		**125.54**		**190.64**		**264.91**		**394.93**		**533.53**

Table 5 17 Calculation of the efficiency of the Preventive System as well as a projected calculation until five years after implementation

Table 5.17 presents a probable projection of the efficiency of the Preventive System until five years after the first implementation. Figure 5.7 illustrates the efficiency increase over time.

From Table 5.16, 5.17 and Figure 5.7 the Preventive System can be described as highly efficient.

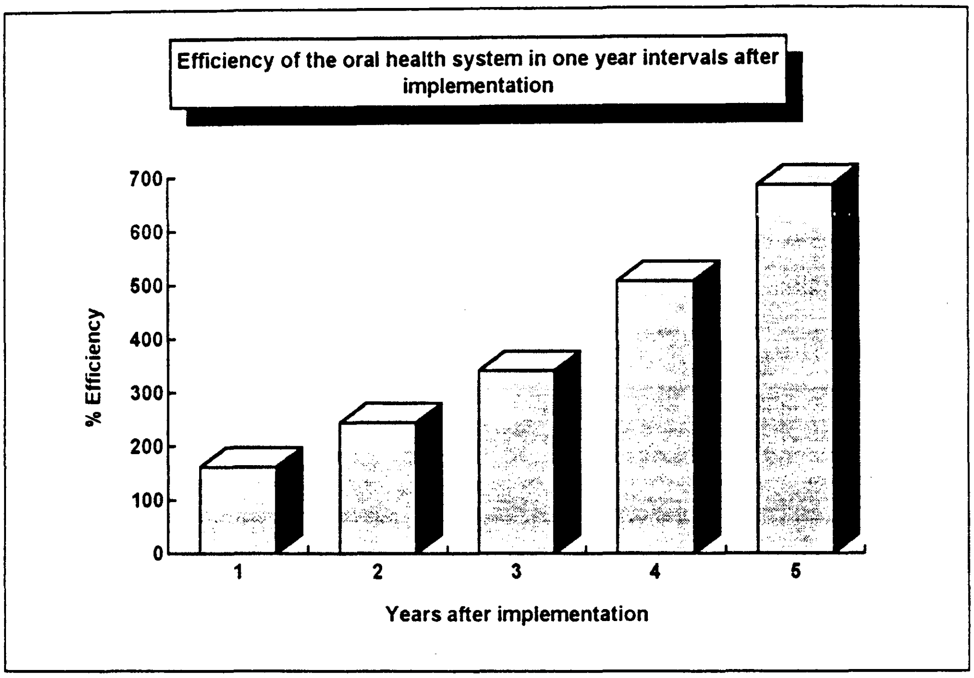

Figure 5.7: An illustration of the efficiency of the Preventive System

2.2.5. Effectiveness

According to Hitchins (1992, p 93) effectiveness can be evaluated by combining measures of the degree to which a system's emergent properties meet - or fail to meet - an ideal. The effectiveness of the Preventive System is evaluated under the three headings (Proposed by Hitchins (1992, p 93)): [1] Contribution to the containing systems' objectives; [2] Co-operation with sibling systems; and [3] Harmony of contained systems. Figure 5.8 illustrates a probable diagram of the Preventive System with its contained systems, its sibling systems and its containing system.

2.2.5.1. Contribution to the containing systems' objectives

As indicated in Figure 5.8 the containing system of the Preventive System is the Oral Health Service of the SAMS and on a higher level the South African Medical Service *per se*. The contribution of the Preventive System to its containing systems' objectives is evaluated according to the following criteria:

⇨ Oral health promotion

The Preventive System promoted oral health as described in paragraph 2.1.1.2 of this chapter. According to paragraph 2.1.1.2 of this chapter caries prevalence was reduced by 84% after two years. It can thus be concluded that the Preventive System promoted the oral health of the children population with regard to dental caries by approximately 84%. As 85% of dental caries was contributed by the molars, the sealant project could only prevent 85% of the total DMFT. The 84% prevented, thus actually makes the Preventive System 99% effective.

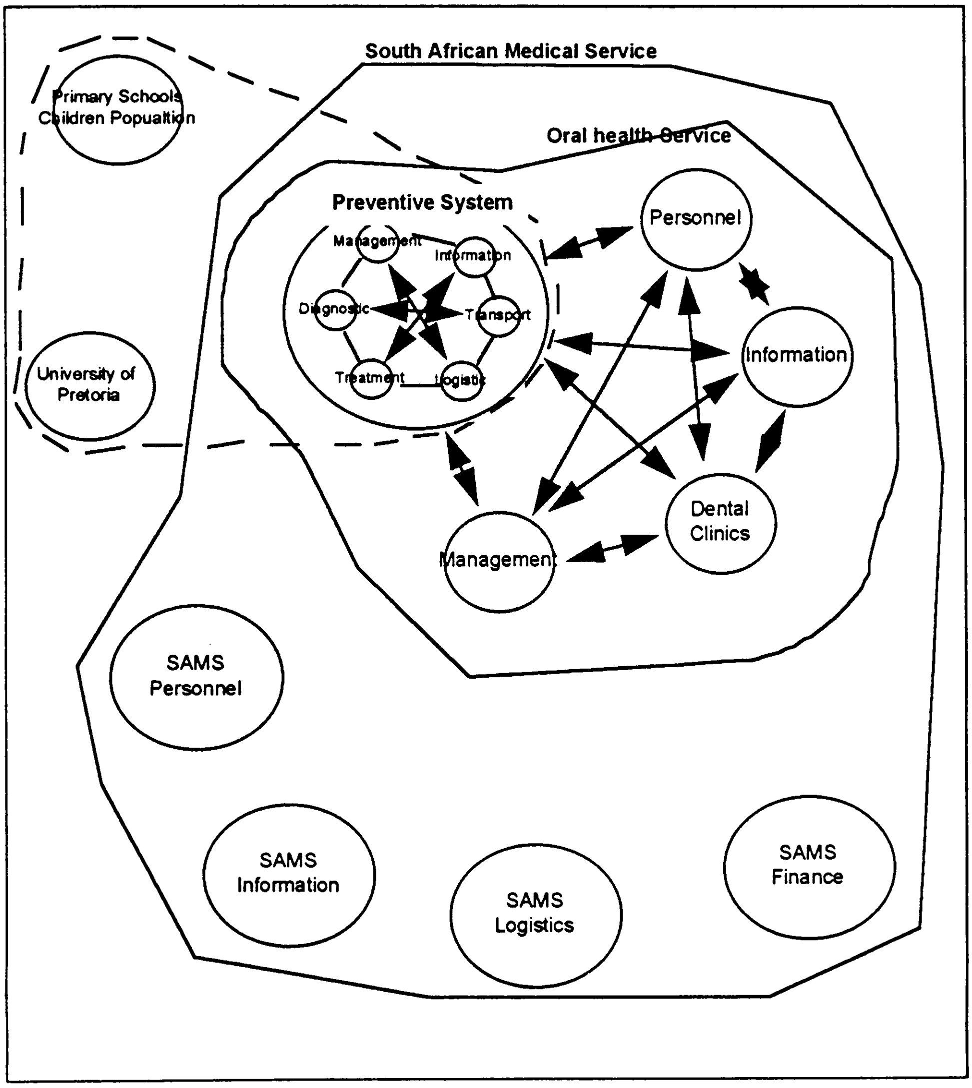

Figure 5.8: The Preventive System with its siblings, contained and containing systems.

- Patient satisfaction

  The patient satisfaction of the Preventive System was discussed in paragraph 2.2.3.1. According to the results of the question discussed, 91,18 percent of the children population was satisfied with the service they received.

- Self-care

  The SADF population is a tooth-brushing population as described in paragraph 2.4.1.5.1.4 of Chapter 2 (99,25% of the population brush their teeth once or more a day). The frequency and level of home oral health care is high. Another perspective on self-care is that a population is able to maintain self-care until disease and/or pain appears. If this perspective is applied to this study it can be stated that where the incidence of disease declined, the probability to maintain self-care increased. The prevalence of disease decreased by 84% after two years and it can thus be argued that the possibility to maintain self-care increased by 84%.

- Availability and accessibility

  The availability and accessibility are discussed in paragraph 2.2.2 of this chapter. It is concluded that the availability and accessibility of the Preventive System were more than 80 percent.

- Acceptability

  The acceptability of the Preventive System is discussed in paragraph 2.2.3 of this chapter. It is concluded that the acceptability of the Preventive System was between 91,18 and 94,12 percent.

- Continuity

  The continuity of the Preventive System depends upon at least two aspects namely the continuous implementation of the project and the opportunity that, if SADF members are transferred, the children will still partake in a similar project at their new destination.

  Concerning the continuous implementation of the project, this Preventive System will be implemented as long as its evaluation is positive. Concerning the second aspect of continuity, it would be wrong to evaluate this Preventive System according to this standard as one of the objectives of the Preventive System was to establish a model of how the concept could be operationalized in the SAMS. Since 1991 however similar Preventive Systems were implemented in three other Medical commands and the rest of the Medical commands are also planning similar Preventive Systems.

It can thus be concluded that the continuity of the Preventive System was and will be, as long as it is evaluated positively, 100 percent.

⇨ Adaptability

Adaptability, according to Hitchins (1992, p 94) is evaluated by using two issues, namely flexibility and expandability. The three years that the Preventive System was implemented clearly proved the flexibility and expandability of the project. The number of children per school and in total, as well as the number of schools varied significantly from year to year. The fact that the Preventive System was managed and planned as a systems project with the making of essential decisions at the operational level contributed to the flexibility and expandability of the Preventive System.

Table 5.18 summarizes the effectiveness of the Preventive System concerning the contribution to the containing systems' objectives, by valuing every criterion described above on a scale from 1 to 10. The individual values are summarized and valued as a percentage to present a single value for effectiveness.

Criterion	Value
Oral health promotion	6,8
Patient satisfaction	9,1
Self-care	5,8
Availability and Accessibility	8,0
Acceptability	9,2
Continuity	10,0
Adaptability	7,0
TOTAL (70)	55,9
EFFECTIVENESS PERCENTAGE	79,85

Table 5.18: Calculation of the effectiveness of the Preventive System concerning the system's contribution to the containing systems' objectives.

2.2.5.2. Co-operation with sibling systems

The following sibling systems were identified (see Figure 5.8): [1] Preventive System; [2] Personnel system; [3] Dental information system; [4] Dental clinics; [5] Dental services management system; and for the course of the project [6] Children population in primary schools and [7] The Dental Faculty, University of Pretoria.

2.2.5.2.1. Co-operation between the Preventive System and the Personnel System of the Dental Services

The Preventive System used personnel from the Personnel System of the Dental Services for the duration of the project during the three years of implementation. The absence of these personnel during the implementation of the project increased the difficulty of the dental personnel to cope with the curative demand from the total population. During 1990 a total of eight clinical dentists were used, during 1991 only one and during the final year no clinical dentists were used. During the final two years only dental assistants and clerical personnel were used. This was possible only because of the co-operation between the Preventive System and the Dental Faculty, University of Pretoria - described later. To minimize the problem of personnel absence from normal duties in dental clinics they were only used until noon, whereafter they went back to their clinics and were available for the second half of every day.

2.2.5.2.2. Co-operation between Preventive System and the Dental information system

The dental information system provided the Preventive System with information on the preventive action being taken in dental clinics, the proportion of children visiting dental clinics on a regular basis, and on the approximate number of children attending primary schools. The Preventive System provided the dental information system with information concerning the oral health status of children, their treatment needs as well as information concerning the operation of the Preventive System. Top management used this information for making decisions and policy.

2.2.5.2.3. Co-operation between Preventive System and Dental clinics

The Preventive System referred children with curative treatment needs to dental clinics for the necessary treatment. This increased the curative burden on the dental clinics. The reduction of dental caries due to the Preventive System, however, reduced the curative backlog and will in future provide more time to be spent on secondary and tertiary care.

2.2.5.2.4. Co-operation between the Preventive System and the Oral Health Services management system

The management system initiated, planned and managed the Preventive System. The Preventive System provided the management system with information leading to policy.

2.2.5.2.5. Co-operation between the Preventive System and the children population in primary schools

The Preventive System took dental care to the community making it more accessible, available and acceptable. Children were absent from their classrooms for not more than 30 minutes. During these 30 minutes their caries risk was reduced by more than 50% and the contact with the Preventive System *per se* probably had a positive influence on their attitude towards oral health.

2.2.5.2.6. Co-operation between the Preventive System and the University of Pretoria

The University of Pretoria provided the Preventive System with oral hygiene students. From 1991 these students, instead of dentists, were used to do fissure sealants. This was a training opportunity for the University of Pretoria as the availability of children with a need for sealants, visiting the Dental hospital, is decreasing.

2.2.5.3. Harmony of contained systems.

The following contained systems (contained within the Preventive System) were identified: [1] Diagnostic system; [2] Treatment system; [3] Logistical system; [4] Transport system; [5] Information system; and [6] Management system. The harmony of these contained systems is illustrated by the high effectiveness level of the emergent properties.

The effectiveness of the Preventive System was evaluated following the framework of contribution to the containing systems' objectives, co-operation with sibling systems and harmony of contained systems. It can be concluded that the Preventive System was highly effective.

2.2.6. Cost-effectiveness

According to Hitchins (1992, p 95) cost-effectiveness seeks to maximize "value for money", by maximizing the ratio of effectiveness to cost. Cost-effectiveness can thus be seen as "valued emergent properties per cost" (Hitchins, 1992, p 95). Hitchins (1992, p 96) proposed a process to evaluate cost effectiveness namely: [1] Potential solutions are generated; [2] Each solution's effectiveness is valued according to the same set of criteria; [3] The cost for each solution is determined; and finally [4] The effectiveness and cost is ratioed - the highest ratio indicates the preferred solution.

The options for the Oral Health Service of the SAMS were a preventive approach, as implemented through the Preventive System, and a curative approach, as services are traditionally rendered. Table 5.19 evaluates the effectiveness of these two options according to the criteria identified in paragraph 2.2.5.1.

Criterion	Preventive Option	Curative Option
Oral health promotion	6,8	0,0
Patient satisfaction	9,1	9,1
Self-care	5,8	0,0
Availability and Accessibility	8,0	6,0
Acceptability	9,2	8,0
Continuity	10,0	10,0
Adaptability	7,0	7,0
TOTAL (70)	55,9	40,1
EFFECTIVENESS PERCENTAGE	79,85	57,29

Table 5.19: Calculation of the effectiveness of the two options available for the Oral Health Service of the SAMS

The next step was to determine the cost for the two options. Table 5.20 presents the effectiveness, cost and cost-effectiveness ratio as calculated for every 1000 children being serviced by the two options.

	Preventive Option	**Curative Option**
Effectiveness	79,85	57,29
Cost	9490,00	11862,00
Ratio (%)	0,843	0,481

Table 5.20: Calculation of the cost-effectiveness ratio for the two options available for the Oral Health Service of the SAMS.

Figure 5.9 presents the cost-effectiveness of the two options graphically.

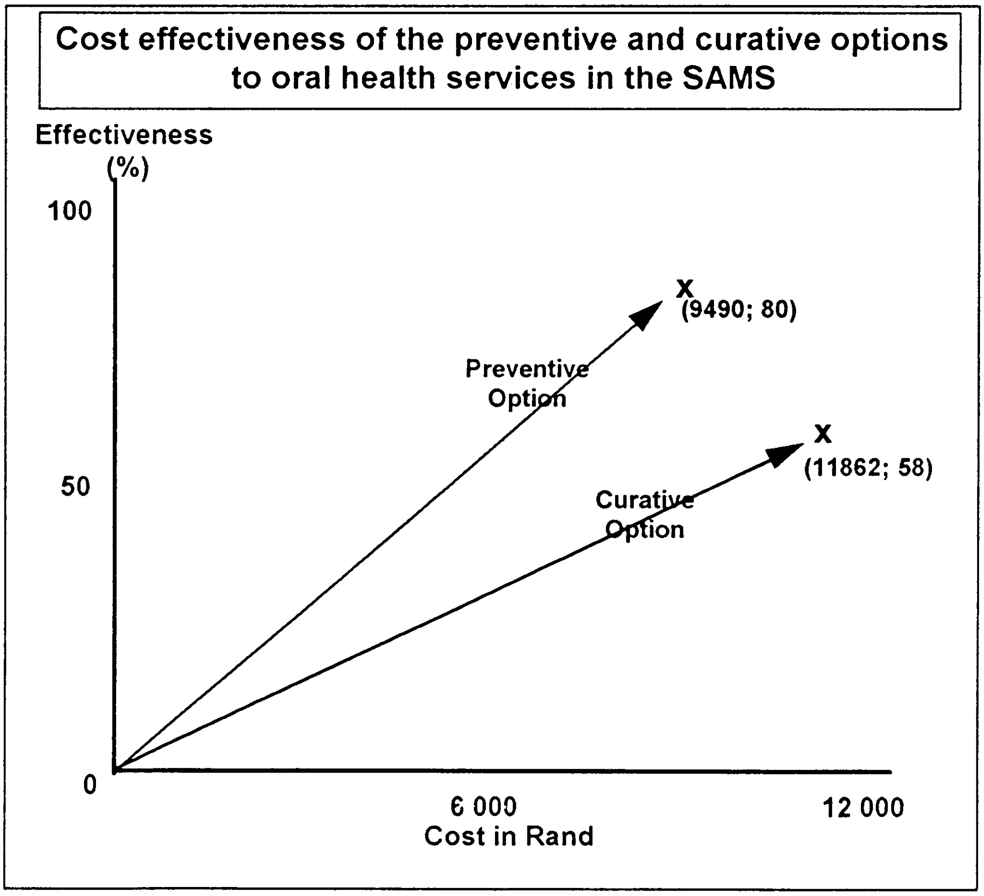

Figure 5.9: Presentation of the cost-effectiveness of the preventive and curative options available to the Oral Health Service of the SAMS.

From this discussion it is clear that the preventive option (Preventive System) has a more favourable cost-effective ratio than the curative approach.

2.2.7. Net contribution

According to Hitchins (1992, p 109) the role of cost is placed into perspective by Net Contribution. Net contribution overcomes the tendency of cost-effectiveness to concentrate on the positive aspects. The net contribution process puts the positives in balance with the negatives (Hitchins, 1992, p 100). The process of net contribution follows the steps hereunder:

- ⇨ Identification of the containing system and the sibling systems contained within it, and to apportion their attribute in such a way that the containing system's requisite features are realized.
- ⇨ Evaluate the system in focus against this idealized contribution budget.

Table 5.21 presents the sibling systems contained within the Oral Health Service system, as well as an idealized budgeted apportioning between the contained sibling systems.

	Contained systems				
Emergent properties	**SIF**	**A**	**B**	**C**	**D**
POSITIVE CONTRIBUTIONS	**49**	**13**	**12**	**17**	**9**
Health Promotion	65	10	10	10	5
Patient satisfaction	65	10	10	10	5
Self-care	60	15	5	15	5
Availability & Accessibility	45	15	10	15	15
Acceptability	45	15	10	15	15
Continuity	30	20	15	25	10
Adaptability	30	10	25	30	5
NEGATIVE CONTRIBUTIONS	**47**	**31**	**6**	**8**	**8**
Capital cost	75	5	10	5	5
Operating cost	30	55	5	5	5
Human behaviour (dentists)	45	30	5	10	10
Dentist compensation	40	35	5	15	5
NET CONTRIBUTION	***2***	***-18***	***6***	***9***	***1***

SIF = System in focus (Service rendering systems)
A = Personnel system
B = Information system
C = Management system
D = Logistical system

Table 5.21: Sibling contribution budget on the Oral Health Service of the SAMS

Table 5.22 presents the evaluation of the two options for rendering a dental service, namely the traditional curative approach and the preventive approach (Preventive System or Sealant project).

Emergent properties	Service Delivery System		
	Idealized	**Curative Option**	**Preventive Option**
POSITIVE CONTRIBUTIONS	**49**	**37**	**49**
Health Promotion	65	35	65
Patient satisfaction	65	65	65
Self-care	60	30	65
Availability & Accessibility	45	35	45
Acceptability	45	45	45
Continuity	30	30	30
Adaptability	30	20	30
NEGATIVE CONTRIBUTIONS	**47**	**48**	**31**
Capital cost	75	75	75
Operating cost	30	30	25
Human behaviour	45	45	15
Dentist compensation	40	40	10
NET CONTRIBUTION	***2***	**-11**	**18**

Table 5.22: Evaluating the net contribution of the service rendering system options according to the idealized values determined in Table 5.21.

According to the net contribution evaluation of the Preventive System (Sealant project) it is concluded that the Preventive System had a positive net contribution to the Oral Health Service of the SAMS as a contained system. If all systems were evaluated using Net contribution, and if only positive solutions were accepted, then a hierarchy of net positive systems contained within net positive systems should develop (Hitchins, 1992, p 109).

3. Process evaluation

Process evaluation is an internal view of a system and is actually evaluated by assessing the efficiency of the system as deliberated in paragraph 2.2.4. Brief comments on facilities and equipment, administration, and personnel are however given below.

3.1. Facilities and Equipment

The facilities and equipment used proved to have supported the Preventive System sufficiently. The rooms provided by the school system were adequate regarding space, safety and security, water, electricity and lighting. The mobile equipment used were easy to install and transport, and it supported the necessary action effectively.

3.2. Administration

The administration of the Preventive System proved to be effective and efficient. All the information recorded was useful in planning and evaluation. No data was recorded that was unnecessary or useless.

3.3. Personnel qualifications and training

The Preventive System started in 1990 with the utilization of dentists for both examination as well as the application of sealants. During 1992 only one dentist was used to examine and determine treatment needs. Instead of dentists, oral hygiene students from the University of Pretoria were used to apply sealants. The use of dentists to apply sealants during 1990 was an "overkill". It had a negative influence on efficiency as evaluated in paragraph 2.1.2. Oral hygienists can definitely also be trained to examine patients and determine treatment needs, which will improve efficiency.

4. Management and Planning

According to Koontz and Weihrich (1988, p 8) the evaluation of management includes effectiveness on a strategic level and efficiency on an operational level. According to the deliberation on effectiveness in paragraph 2.2.5 and efficiency in paragraph 2.2.4 of this chapter it is concluded that the management of the Preventive System was effective and efficient. The planning of the Preventive System according to the guidelines posed by Kerzner (1992, p 83) proved to be comprehensive, effective and efficient.

5. Summary

The Preventive System was evaluated following the framework of impact evaluation, process evaluation and finally evaluation of management and planning. The evaluation of the impact of the Preventive System was divided into two main sections, namely the sealants as a modality and secondly an evaluation from a systems perspective. The evaluation of the sealants *per se* was done according to the dental literature. This approach seems to be inadequate for the health industry as it tends to neglect system outputs and system inputs.

The systems approach to evaluation however seems promising, and especially the Net contribution technique will assist in the development of positive health delivery systems.

The Preventive System was entered for the National Productivity Institute's national productivity award competition of 1993. The entry received a merit certificate for the increase in productivity induced within the Oral Health Service of the SAMS (Appendix N). This award hopefully indicated to the health industry that: [1] The output of a health system should be seen as health and not only as treatment of disease; and [2] Productivity equals prevention.

The evaluation of the Preventive Project is discussed in more detail and conclusions are drawn in Chapter 8.

CHAPTER 6

ACTIONS TO IMPROVE THE SITUATION (2) (PLANNING, DEVELOPMENT AND IMPLEMENTATION OF THE PERFORMANCE MEASUREMENT SYSTEM)

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CHAPTER 6

ACTIONS TO IMPROVE THE SITUATION (2) (PLANNING, DEVELOPMENT AND IMPLEMENTATION OF THE PERFORMANCE MEASUREMENT SYSTEM)

1. Introduction

The Performance Measurement System was conceptually developed through the stages of the Soft Systems Methodology described in Chapter 3. Feasible and desirable change was defined as: The development, implementation and managing of a performance measurement system that will set objectives, identify criteria, establish standards, measure and improve performance in the Oral Health Service of the SAMS. Chapter 6 is concerned with the planning, development and implementation of the Performance Measurement System in the Oral Health Service of the SAMS. In a review of the literature on performance and performance measurement (Appendix C), the Objectives Matrix was identified as the most appropriate measurement tool for the Oral Health Service of the SAMS. The Objectives Matrix was planned, developed and implemented according to the guidelines in Appendix C, paragraph 9.1. In this chapter the organizational structure and communication are briefly discussed as a background, whereafter management planning and training, staff commitment and training, the actual development of the Objectives Matrix, the implementation of the Objectives Matrix in the Oral Health Service of the SAMS, and finally the reporting and accountability of the performance system are deliberated.

The framework of Chapter 6, as well as its orientation within this dissertation is presented in Figure 6.1.

2. Organizational structure and communication

The South African Medical Service is a complex and large organization providing a health service to the South African Defence Force geographically situated in all the regions of the Republic of South Africa. The extent and structure of the organization, as well as the distances between service points complicate communication and the process of change. To understand the channel of communication and the command line in the Oral Health Service of the South African Medical Service, the organizational structure is presented in Figure 6.2.

CHAPTER 3
DEVELOPMENT OF RELEVANT SYSTEMS

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CHAPTER 6
ACTIONS TO IMPROVE THE SITUATION 2
(PLANNING, DEVELOPEMNT AND IMPLEMENTATION OF THE PERFORMANCE MEASUREMENT SYSTEM)

1. Introduction	
2. Organizational structure and communication	
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4. Staff commitment and training	4.1 Announcement of the program 4.2 Training of staff in productivity concepts 4.3 Training of staff in supporting techniques 4.4 Development of Objectives Matrix
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7. Reporting and accountability	7.1 Dental clinic level 7.2 Medical command level 7.3 Headquarters level
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CHAPTER 7
EVALUATION OF THE PERFORMANCE MEASUREMENT SYSTEM

Figure 6.1: Conceptual framework and overall orientation of Chapter 6.

With this background of the complexity and extent of the SAMS the first step in the development of the Performance Measurement System (Objectives Matrix) was to train Staff Officers Oral Health in charge of the different medical commands and to ensure their involvement in the planning and development of the system.

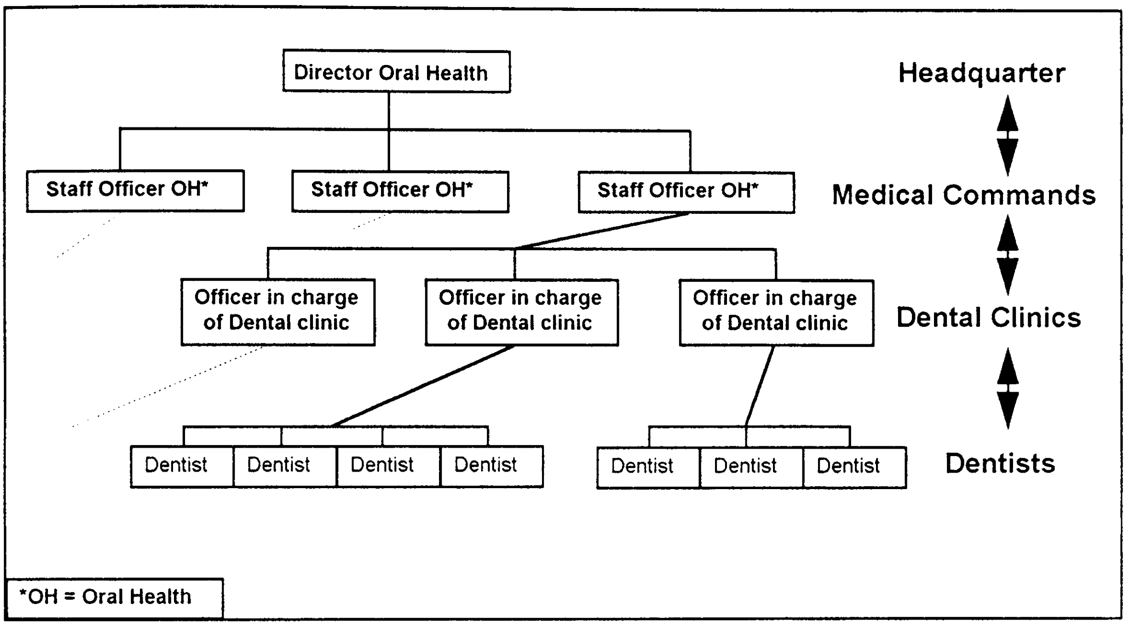

Figure 6.2: The Organizational structure of the Oral Health Service (South African Medical Services)

3. Management planning and training

The management planning and training phase consisted of four modules:

- Definition of the point of departure.
- Exposure to productivity concepts and measurement techniques.
- Exposure to supporting techniques.
- Decisions on the structure of the improvement system.

These four steps are discussed in more detail.

3.1. Definition of the point of departure

The reason to improve productivity followed from the rich picture described in Chapter 2. In short the following reasons for improving productivity were stated:

- The continuous decline in available resources.
- The change in the manpower situation - making dentists more expensive and less available.
- The uncertainty about the nature of the "product" or service rendered.

3.2. Exposure to productivity concepts and measurement techniques

The Director Oral Health and the Staff Officers Oral Health meet twice a year to undertake strategic planning and management and thereby give direction to the Oral Health Service in general. Since 1989 the Director Oral Health had involved various consultants to introduce the Staff Officers Oral Health to the following:

- The productivity dilemma of South Africa and a broad perspective of the organization's productivity position.
- Productivity concepts.
- How to define outputs, inputs and productivity ratios.
- How to identify and define the key factors which influence productivity.

3.3. Exposure to supporting techniques

During these work sessions the dental team was exposed to a variety of talks and discussions covering the following topics:

- Elements of planning
- Management of change
- Problem solving
- Decision making and goal setting
- Motivation
- Communication
- Group techniques

3.4. Decisions on the structure of the improvement programme

The Directorate of Dentistry decided to start the implementation of a productivity improvement plan in the Northern Medical Command. Top management decided to firstly develop and implement an Objectives Matrix in the Northern Medical Command in order to test the concept on a smaller scale. It was decided to obtain the involvement and participation of all the dental officers of the Northern Medical Command in order to get ownership and inputs on a level as wide as possible. The only guideline set at this stage was that primary prevention should be a priority. The responsibility to develop and implement the programme was delegated to major H Viljoen (Project leader) and the Staff Officer Oral Health of the Northern Medical Command, commandant C De Jager.

The definition of the point of departure, exposure to productivity concepts and measurement techniques, exposure to supporting techniques, and the decisions on the structure of the improvement programme were discussed as part of management planning and training. The next step was to train the dental officers in the Northern Medical Command and get their commitment to the Performance Measurement System.

4. Staff commitment and training

During this phase management attended to the very important aspect of staff commitment and training. This phase also consisted of four modules, namely:

- ⇨ Announcement of the programme (system).
- ⇨ Training of staff in productivity concepts and measurement techniques.
- ⇨ Training of the staff in supporting techniques.
- ⇨ Development of the Objectives Matrix.

These modules, which were followed during five working sessions organized by the project leader, are discussed in more detail.

4.1. Announcement of the programme

During this session the following steps were followed:

- ⇨ Top management's decisions and inclination regarding performance were stated
- ⇨ The overall productivity profile of the Oral Health Service of the SAMS was discussed in detail as well as the overall goals of the programme
- ⇨ The overall benefits of the programme to the organization and to the staff were discussed
- ⇨ A detailed outline of how the programme would be structured was discussed
- ⇨ The dental officers were invited to identify improvement opportunities and to participate in the programme

4.2. Training of staff in productivity concepts and measurement techniques

During this phase the dental officers were exposed to productivity concepts, how to define outputs, inputs and productivity ratios, and the principles of the Objectives Matrix.

4.3. Training of staff in supporting techniques

During this phase the dental officers were introduced to the handling of change, problem solving, group interaction and group communication.

4.4. Development of Matrix

Using different group techniques a preliminary Objectives Matrix was developed and proposed to the following work session of top management. During this work session (June 1992), facilitated by the project leader, the final Objectives Matrix was developed, by using inputs gathered by all the Staff Officers Oral Health in a similar way as described for the Northern Medical Command.

The process to train dental staff at the lowest operational level and ensure their commitment to the Performance Measurement System was deliberated. The development of the final Objectives Matrix is discussed next in detail.

5. Development of the Objectives Matrix

According to the preceding discussion the Objectives Matrix was developed with the full co-operation of the employees concerned. The project leader made use of brainstorming and the Nominal group techniques (See Appendix C). During the development the following steps were followed during group discussions:

- Development of the Mission Statement of the Oral Health Service of the SAMS.
- Determination of the aim of the sections Oral Health of the medical commands.
- Determination of the goals of the sections Oral Health of the medical commands.
- Determination of the Objectives, Key Performance Areas and Performance Criteria of the Oral Health Service.
- Determination of the performance scales of the Performance Criteria.
- Determination of the weights of the Performance Criteria.
- Composition of the final Objectives Matrix.

5.1. Mission Statement of the Oral Health Service of the SAMS

The project-leader facilitated the process and the following mission statement was developed and accepted by the Director Oral Health and the Staff Officers Oral Health of the different medical commands.

"We are a dynamic team who strives to achieve optimal oral health, patient satisfaction and self-care for all our patients.

The aim of the Oral Health Service of the South African Medical Service is the rendering of a timely, comprehensive oral health service to all the patients entitled to it. The service comprises of an *operational as well as a base-oriented preventive, curative, rehabilitative and promotive service. Primary prevention is a priority.*

We commit ourselves to:

- ⇨ *high scientific and clinical standards.*
- ⇨ *a professional attitude towards our patients regardless of their seniority, colour, religion, and gender.*
- ⇨ *applied research to benefit our patients and our organization.*
- ⇨ *effective management of our service to ensure efficiency.*

(Directorate Oral Health, 1991, p13)

The following core mission was accepted:

> *"To conquer dental and oral disease in co-operation with our patients."*
> (Directorate Oral Health, 1991, p13)

This mission constitutes the general direction and strategic orientation of the Oral Health Service of the SAMS.

From this mission statement the Staff Officers Oral Health of the different medical commands determined an aim for every medical command, supporting the mission of the total service.

5.2. The aim of the different medical commands

The Staff Officers Oral Health accepted a uniform aim for all the medical commands, namely:

> "To render a comprehensive Oral Health Service to all patients entitled thereto in the responsibility area of the .... Medical Command."
> (Directorate Oral Health, 1991, p15)
>
> .... = The name of each of the medical commands.

This aim supports the Mission of the service and directs Oral Health service within the specific medical command. It also influences the management process of planning, organizing, leading and control. From this aim three different goals were formulated.

5.3. The goals of the different medical commands

The work group accepted the following definition of productivity in oral health care:

> Productivity in oral health care is to achieve oral health in the target population in the most **effective**, **efficient** and **quality** method.

From this definition the following three goals were stated for every medical command.

5.3.1. Oral health promotion (Effectiveness)

This goal is contextualized in the Primary Oral Health Care approach. The aim is to prevent oral disease and promote oral health through primary preventive procedures, supported by an acceptable level of secondary and tertiary prevention. The ultimate goal is to ensure self-care in the total population of the SADF. This goal should be seen as the effectiveness aspect of productivity.

5.3.2. Quality service

This goal supports the quality aspect of productivity in health care, and implies the most suitable quality for the circumstances.

5.3.3. Efficient service

The goal is to render an oral health service with the least amount of resources possible.

Having established the goals of the Oral Health Service of the SAMS, objectives, Key Performance Areas and Performance Criteria were defined.

5.4. Objectives, Key Performance Areas (KPA) and Performance Criteria (PC)

The development of objectives, KPA's and PC's are deliberated under the three goals: Oral Health Promotion; Quality service; and Efficient service

5.4.1. Oral health promotion

Oral health promotion is the most important goal. The following objectives were developed to support this goal:

- To reduce the prevalence and incidence of dental disease in the SADF population.
- To reduce the curative backlog.

These two objectives were developed in the following Key Performance Areas and Performance Criteria. The objective to reduce the prevalence and incidence of dental disease in the SADF population is deliberated first.

5.4.1.1. To reduce the prevalence and incidence of dental disease in the SADF population

Due to the nature of dental disease this is the only way to conserve and promote oral health. This is also the most important objective regarding the Mission statement of the Oral Health Service. Two Key Performance Areas (KPA) were identified in this objective, namely:

- ⇨ Prevention of dental caries.
- ⇨ Prevention of periodontal disease.

5.4.1.1.1. Caries prevention

Due to the age distribution of caries incidence, this KPA is aimed at the prevention of dental caries in children. The Oral Health Service is aware of the fact that the children population is a temporary responsibility, but the treatment of dental caries in children consume approximately 20% of resources, making it a priority to prevent dental caries in this group. The KPA also contributes to the oral health of the total South African population.

The following Performance Criteria (PC) were developed to measure the performance of this KPA.

5.4.1.1.1.1. Number of oral hygiene instructions and/or prophylaxis on children / Number of children visits x 100

This PC is based on the rationale that dental caries cannot develop in the absence of bacterial plaque (Elderton, 1990, p 147), and on the recognized cariostatic effect of fluoridated toothpaste (Harris and Christen, 1991, p 221). The aim was that this PC would rise from the level of 25% to 70%.

Although this PC is measuring performance of dental caries prevention it will also contribute to the promotion of periodontal health.

5.4.1.1.1.2. Number of fissure sealants done on children / Number of restorations done on posterior teeth of children x 100

This PC is based on the evidence that 80% of all dental caries involves pits and fissures (Ripa, 1985, p 373). According to Rossouw (1989, Unpublished) the average DMFT for 12 to 13 year old children in the SADF was 3,92. The permanent molars accounted for more than 80% of the total DMFT, thus approximately 3,14 molars per mouth were diseased. The effectiveness of fissure sealants is reported to be above 70% (Ripa, 1985, p 370). Thus, to be able to eliminate caries on molars (3,14 per mouth) with the use of fissure sealants (effectiveness = 70%) a minimum of four sealants per mouth is needed. If the effectiveness is to be 70% a maximum of one tooth per four sealed will become decayed. This reasoning brought the group to a ratio of 4:1. The aim was thus that this PC would rise from the level of 9% to 400%.

5.4.1.1.2. Prevention of periodontal disease

Due to the age distribution of periodontal disease in the population of the SADF this KPA is aimed at the adult patients. Only one PC were identified to quantify performance in this area.

5.4.1.1.2.1. Number of oral hygiene instructions and/or prophylaxis on adults / Number of adult visits x 100

This PC is based on the ample evidence that plaque control is an effective preventive approach to control periodontal disease (Harris and Christen, 1991, p 72). According to Rossouw (1989, Unpublished) 94% of the adult population needed oral hygiene instructions and prophylaxis to promote their periodontal health. The aim was that this PC would rise from the level of 17% to 80%.

Although this PC was defined to measure prevention of periodontal disease, it would also have an effect on the incidence of dental caries.

The first objective, namely to reduce the prevalence and incidence of dental disease in the clientele of the SAMS, was expanded to the level of performance criteria. The second objective to deliberate is: To reduce the curative backlog.

5.4.1.2. *To reduce the curative backlog*

The reality of the situation is that there is a considerable curative backlog, which ought to be treated curatively. Three KPA's were identified for this objective, namely:

⇨ Curative treatment.
⇨ Patient priorities.
⇨ Treatment priorities.

5.4.1.2.1. Curative treatment

This KPA describes the traditional approach to comprehensive Oral Health Service. The aim of the approach is to treat as much as possible of the existing disease as efficiently as possible. Five PC's were developed to measure performance in this KPA.

5.4.1.2.1.1. Number of plastic restorations / Number of visits x 100

This PC is based on the fact that prevention and oral health promotion will have a declining effect on caries incidence. Furthermore, it will probably inhibit curatively inclined dentists doing possibly unnecessary restorations. The aim was that this PC would decline from the level of 30% to 15%.

5.4.1.2.1.2. Number of plastic restorations / Number of prosthetic replacements

Top management was concerned with the fact that dentists were probably striving after the ideal treatment for all patients, instead of the ideal treatment for the patient concerned. This is especially true in a health care system where patients are entitled to unlimited care and where the financial risk is neither carried by the provider nor the patient. The aim was that this PC would rise from the level of 17 to 100.

5.4.1.2.1.3. Number of extractions / Number of visits x 100

This PC is again based on the fact that prevention and promotion will cause a decline in the number of teeth needing extraction. The aim was that this PC would decline from the level of 4% to 0%.

5.4.1.2.1.4. Number of emergency root canals / Number of completed root canal treatments x 100

This PC is based on the concern of top management that emergency root channels are not followed up by the responsible dentist and are thus never completed. The aim was that this PC would decline from the level of 158% to 50%.

5.4.1.2.1.5. Number of removable prostheses / Number of fixed prostheses x 100

This PC was again based on top management's concern with the fact that dentists were probably striving after the ideal treatment for all patients, instead of the ideal treatment for the patient concerned. The aim was that this PC would rise from the level of 126% to 300%.

5.4.1.2.2. Patient priorities

This KPA primarily supports the goal of the SAMS, namely to ensure a prepared and fit defence force. Only one PC was developed for this KPA.

5.4.1.2.2.1. Number of active member visits / Number of total visits x 100

This PC was based on the dental team's primary task namely to ensure an able and physically fit defence force. The aim was that this PC would rise from the level of 44% to 60%.

5.4.1.2.3. Treatment priorities

This KPA supports the notion that only primary prevention can promote oral health. The result of prevention will not only promote oral health but it will also reduce cost-intensive curative procedures. Only one PC was formulated to measure this KPA.

5.4.1.2.3.1. Number of preventive visits / Number of treatment visits x 100

This PC was based on the vision that the ideal visit to a dentist will only include examination and prevention. The aim was that this PC would rise from the level of 39% to 200%.

The goal to promote oral health in the clientele of the SAMS was discussed under the set objectives. The second goal is that of a quality service.

5.4.2. Quality service

Quality of services rendered is the second goal. It is an integral part of productivity in oral health services. Quality vastly contributes to patient satisfaction and also the corporate image of a health care organization. Only one objective was identified for this goal, namely to deliver a quality Oral Health Service to the population of the SADF.

5.4.2.1. To deliver a quality Oral Health Service to the population of the SADF

The concept quality is wide and not very well defined in literature. For the aim of this study quality refers to the most suitable service. Only one KPA was identified, namely service quality.

5.4.2.1.1. Service quality

The quality of the service is measured via four PC's.

5.4.2.1.1.1.Number of patients completed / Number of total visits x 100

It was top management's concern that treatment plans of patients were not completed. If more treatment plans were completed, patient satisfaction would increase. The aim was that this PC would rise from the level of 34% to 70%.

5.4.2.1.1.2. Number of emergency visits / Number of total visits x 100

The extent of the curative backlog probably contributes to the number of emergency visits experienced. If this backlog is reduced and if preventive actions are introduced the number of emergency visits will decline. The aim was that this PC would decline from the level of 33% to 10%.

5.4.2.1.1.3. Number of restorations replaced / Total number of restorations x 100

Restorations are replaced due to inferior quality and secondary caries. If preventive actions are taken and restorations are placed with more care the number of restorations replaced will decline. The aim was that this PC would decline from the level of 42% to 5%.

5.4.2.1.1.4. Number of temporary fillings / Total number of fillings x 100

This PC was based on top management's belief that temporary fillings are seldom necessary in health systems where no income is generated by the number of fillings done. The aim was that this PC would decline from the level of 20% to 0%.

The goal to enhance the quality of services rendered was deliberated under the only objective: Service quality. The final goal to discuss is: To render an efficient service.

5.4.3. Efficient service

Rendering an efficient service is the third goal. To be efficient is very important in the light of declining resources and of being competitive in any future dispensation. Only one objective was formulated, namely to deliver an oral health service with the least amount of resources.

5.4.3.1. To deliver an oral health service with the least amount of resources

The accent is on the use of resources namely manpower and infrastructure. Two KPA's were identified, namely:

- The optimum use of manpower.
- The optimum use of infrastructure.

5.4.3.1.1. The optimum use of manpower

According to Brown and Comola (1988, p 23) approximately 60% of all resources are spent on manpower, making it the most important resource to control. Two PC's were developed.

5.4.3.1.1.1. Monthly turnover of individual / R 30 000 x 100

This PC was based on the rationale that a dentist should deliver a certain turnover to justify his or her salary. The aim was that this PC would rise from the level of 43% to 100%.

5.4.3.1.1.2. Number of referrals / Number of visits x 100

This PC was based on the belief that referrals should be discouraged, especially in an environment where no income is lost when patients are referred. The aim was that this PC would decline from the level of 1% to 0%.

5.4.3.1.2. The optimum use of infrastructure

This is a difficult KPA to measure. Only one PC was developed to measure performance of this KPA.

5.4.3.1.2.1. (Turnover of the clinic x 1,5) / (Number of surgeries in the clinic x Turnover of the individual)

This PC was based on top management's vision and belief that a dentist should be able to work on more than one dental chair. The aim was that this PC would decline from the level of 1,5% to 1,0%.

The development of the performance criteria for the Objectives Matrix was discussed as an expanding process building a hierarchy of goals, objectives, Key Performance Areas and Performance Criteria. A complete list of the final performance criteria is presented in Table 6.1.

Number	Performance Criteria
1	Number of oral hygiene instructions and/or prophylaxis on children / Number of children visits x 100
2	Number of fissure sealants done on children / Number of restorations done on posterior teeth of children x 100
3	Number of oral hygiene instructions and/or prophylaxis on adults / Number of adult visits x 100
4	Number of plastic restorations / Number of visits x 100
5	Number of plastic restorations / Number of prosthetic replacements
6	Number of extractions / Number of visits x 100
7	Number of emergency root channels / Number of completed root channel treatments x 100
8	Number of removable prosthesis / Number of fixed prosthesis x 100
9	Number of active member visits / Number of total visits x 100
10	Number of preventive visits / Number of total visits x 100
11	Number of patients completed / Number of total visits x 100
12	Number of emergency visits / Number of total visits x 100
13	Number of restorations replaced / Total number of restorations x 100
14	Number of temporary fillings / Total number of fillings x 100
15	Monthly turnover of individual / R 30 000 x 100
16	Number of referrals / Number of visits x 100
17	(Turnover of the clinic x 1,5) / (Number of surgeries in the clinic x Turnover of the individual)

Table 6.1: A list of the final performance criteria in the development of the Objectives Matrix.

Following the completion of the performance criteria, performance scales for all the criteria were developed.

5.5. Performance scales

Performance scales were determined to measure any change in performance. These scales were developed by:

- Determining the current level of performance (Level 3)
- Determining the realistic goal (Level 10)

- ⇨ Determining the minimum acceptable level (Level 0)
- ⇨ Calculating the eleven point performance scale (From level 0 to 3 and from level 3 to 10)

The final performance scale for all the performance criteria are listed in Table 6.2.

5.6. Relative weights of Performance Criteria

Relative weight values were contributed to the criteria in order to establish the difference in importance between the different criteria. The total value of the weights is 100. The relative weights for the different performance criteria are shown in Table 6.2.

PC		Performance Scale										
Nr	Wght	0	1	2	3	4	5	6	7	8	9	10
1	2.8	0	8	17	25	31	38	44	51	57	64	70
2	3.6	0	3	6	9	65	120	176	232	288	344	400
3	2.6	0	6	11	17	26	35	44	53	62	71	80
4	2.5	100	77	53	30	28	26	24	21	19	17	15
5	2.5	0	6	11	17	29	41	53	64	76	88	100
6	1.8	10.0	8.0	6.0	4.0	3.4	2.9	2.3	1.7	1.1	0.6	0.0
7	3.8	300	252	205	158	143	127	112	96	81	65	50
8	2.6	10	49	87	126	151	176	201	225	250	275	300
9	4.5	10	21	33	44	46	49	51	53	55	58	60
10	4.9	0	13	26	39	62	85	108	131	154	177	200
11	1.4	2	13	23	34	39	44	49	55	60	65	70
12	3.8	50	44	39	33	30	26	23	20	17	13	10
13	3.4	50	47	45	42	37	31	26	21	16	10	5
14	5.2	50	40	30	20	17	14	11	9	6	3	0
15	50.0	10	21	32	43	51	59	67	76	84	92	100
16	2.7	5.0	3.7	2.3	1.0	0.9	0.7	0.6	0.4	0.3	0.1	0.0
17	1.9	3.0	2.5	2.0	1.5	1.4	1.4	1.3	1.2	1.1	1.1	1.0

Table 6.2: The relative weights and performance scales of the 17 criteria listed in table 6.1.

Having completed the development, the determination of performance scales and the relative weights of the PC's, the final step was to compile the final Objectives Matrix from the information generated.

5.7. Composition of the Objectives Matrix

Figure 6.3 illustrates the final Objectives Matrix that was composed from the information in the preceding steps.

The development of the Objectives Matrix was deliberated in detail. The discussion now moves to the operational implementation.

OBJECTIVES MATRIX

Name : ______________________ Date : ______________

Clinic : ______________________ Cmdmt______________

KP-Areas: Caries-prevention | Perio prevent | Curative Treatment | Patient priority | Treat prior | Quality | Manpower Utilization | Infra-structure

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Performance Criteria	OHI & Prophylaxes/Child Visits	Fissure sealants/Post Rest on Child	OHI & Prophylaxes/Adult Visits	Plastic Rest/Total Visits	Plastic Restorl/Prostic Replacement	Number Extractions/Total Visits	Emergency Root/Completed Root	Remove Prosthesis/Fixed Prosthesis	Number active member/Total Visits	Preventive Visits/Treatment Visits	Patients Completed/Total Visits	Emergency Visits/Total Visits	Restorations Replaced/Total Restorations	Temporary Rest/Total Restorations	Monthly Turnover/R30 000	Number Referals/Total Visits	Turnover Clinic*1.5/Number Surgeries*Turnover Individual
Performance																	
10 Objective	70	400	80	15	100	0.0	50	100	60	200	70	10	5	0	100	0.0	1.0
9	64	344	71	17	88	0.6	65	88.5	58	177	65	13	10	3	92	0.1	1.1
8	57	288	62	19	76	1.1	81	75	55	154	60	17	16	6	84	0.3	1.1
7	51	232	53	21	64	1.7	96	62.5	53	131	55	20	21	9	76	0.4	1.2
6	44	176	44	24	53	2.3	112	50	51	108	49	23	26	11	67	0.6	1.3
5	38	120	35	26	41	2.9	127	37.5	49	85	44	26	31	14	59	0.7	1.4
4	31	65	26	28	29	3.4	143	25	46	62	39	30	37	17	51	0.9	1.4
3 Standard	25	9	17	30	17	4.0	158	12.5	44	39	34	33	42	20	43	1.0	1.5
2	17	6	11	53	11	6.0	205	10	33	26	23	39	45	30	32	2.3	2.0
1	8	3	6	77	6	8.0	252	7.5	21	13	13	44	47	40	21	3.7	2.5
0 Lowest	0	0	0	100	0	10.0	300	5	10	0	2	50	50	50	10	5.0	3.0
Score																	
Weight (100)	2.8	3.6	2.6	2.5	2.5	1.8	3.8	2.6	4.5	4.9	1.4	3.8	3.4	5.2	50	2.7	1.9
Value																	

Performance Scale

PERFORMANCE INDICATOR /1000

Figure 6.3: The Objectives Matrix for measurement of performance in the Oral Health Service of the SAMS

6. Implementation

Although the development process was part of the implementation of the Objectives Matrix, the final operationalization was critical due to the extent of the performance criteria and the variables concerned. To minimize the administrative effort needed to actually implement the Objectives Matrix on the level of the dentist in the surgery, a computer system was developed that generates two reports for each dentist on a monthly base, namely:

- ⇨ Standard Report
- ⇨ Objectives Matrix Report

6.1. Standard Report

This report generates the input variables needed to produce the Objectives Matrix. An example of the report is illustrated in Table 6.3.

Standard Report for XXXXXXX Dental Clinic
for the month #######

Dentist : No ######## - Name XXXXXXXXXXXX

Total Visits	176.0
Active members	90.0
Children visits	81.0
Adult visits	436.0
Emergency visits	30.0
Patients completed	140.0
Children visits with OHI/Proph	24.0
Adult visits with OHI/proph	117.0
Preventive Visits	153.0
Treatment visits	364.0
Fissure sealants on children	0.1
Post restorations on children	39.0
Temporary restorations	6.0
Plastic restorations	69.0
Prostetic replacements	4.0
Restorations and crowns replaced	4.0
Restorations and crowns	75.0
Removable prosthesis	29.0
Fixed prosthesis	1.0
Emergency rootchannel	1.0
Completed rootchannel	1.0
Extractions	2.0
Referrals	0.1
Turnover of dentist	21 227.36
Turnover of clinic	46 319.81
Number of surgeries in clinic	5.0

Table 6.3: An example of a Standard Report generated as input for the calculations of the Objectives Matrix.

6.2. Objectives Matrix Report

This report calculates the actual performance, scores, weighted value for every performance criteria, as well as the final performance indicator for every dentist on a monthly base. An example of the report is illustrated in Table 6.4.

Objectives Matrix for XXXXXXX Dental Clinic
for the month ####

Dentist : No ######## - Name XXXXXXXXXX

PC No.	Perf	Score	W/Value
1. :	29.6	4.0	11.2
2. :	0.3	0.0	0.0
3. :	26.8	4.0	10.4
4. :	39.2	3.0	7.5
5. :	17.3	3.0	7.5
6. :	1.1	8.0	14.4
7. :	100.0	7.0	26.6
8. :	29.0	4.0	10.4
9. :	51.1	6.0	27.0
10. :	42.0	3.0	14.7
11. :	79.5	0.0	14.0
12. :	17.0	8.0	30.4
13. :	5.3	10.0	34.0
14. :	8.0	7.0	36.4
15. :	70.8	6.0	300.0
16. :	0.1	10.0	27.0
17. :	0.7	10.0	19.0
	Performance Indicator		590.5

Table 6.4: An example of the Objectives Matrix Report generated from the Standard Report in Table 6.3.

The planning, development and implementation of the Objectives Matrix in the Oral Health Service of the SAMS were deliberated. Finally the reporting process to ensure commitment and accountability is presented.

7. Reporting and accountability

To ensure commitment, ownership and accountability the following reporting process is followed at the different organizational levels.

7.1. Dental Clinic level

- Every dentist working in a dental clinic requests and receives his/her Standard report and Objectives Matrix report on a monthly base.
- Dentist verifies the information and completes his/her Objectives Matrix. (Example see Figure 6.4 completed from the information in Tables 6.3 and 6.4.)

OBJECTIVES MATRIX

Name : ______________________ **Date :** ______________________

Clinic : ______________________ **Cmdmt** ______________________

KP-Areas	Caries-prevention			Perio prevent	Curative Treatment					Patient priority	Treat prior	Quality				Manpower Utilization	Infra-structure
Performance Criteria	OHI & Prophylaxes/Child Visits	Fissure sealants/Post Rest on Child	OHI & Prophylaxes/Adult Visits	Plastic Rest/Total Visits	Plastic Restor/Prostic Replacement	Number Extractions/Total Visits	Emergency Root/Completed Root	Remove Prosthesis/Fixed Prosthesis	Number active member/Total Visits	Preventive Visits/Treatment Visits	Patients Completed/Total Visits	Emergency Visits/Total Visits	Restorations Replaced/Total Restorations	Temporary Rest/Total Restorations	Monthly Turnover/R30 000	Number Referals/Total Visits	Turnover Clinic*1.5/Number Surgeries/Turnover Individual
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Performance	29,6	0,3	26,8	34,2	17,3	1,1	100	29,0	51,1	42,0	79,5	17,0	5,3	8,0	70,8	0,1	0,7
10 Objective	70	400	80	15	100	0.0	50	100	60	200	70	10	5	0	100	0.0	1.0
9	64	344	71	17	88	0.6	65	88.5	58	177	65	13	10	3	92	0.1	1.1
8	57	288	62	19	76	1.1	81	75	55	154	60	17	16	6	84	0.3	1.1
7	51	232	53	21	64	1.7	96	62.5	53	131	55	20	21	9	76	0.4	1.2
6	44	176	44	24	53	2.3	112	50	51	108	49	23	26	11	67	0.6	1.3
5	38	120	35	26	41	2.9	127	37.5	49	85	44	26	31	14	59	0.7	1.4
4	31	65	26	28	29	3.4	143	25	46	62	39	30	37	17	51	0.9	1.4
3 Standard	25	9	17	30	17	4.0	158	12.5	44	39	34	33	42	20	43	1.0	1.5
2	17	6	11	53	11	6.0	205	10	33	26	23	39	45	30	32	2.3	2.0
1	8	3	6	77	6	8.0	252	7.5	21	13	13	44	47	40	21	3.7	2.5
0 Lowest	0	0	0	100	0	10.0	300	5	10	0	2	50	50	50	10	5.0	3.0
Score	4	0	4	3	3	8	7	4	6	3	0	8	10	7	6	10	10
Weight (100)	2.8	3.6	2.6	2.5	2.5	1.8	3.8	2.6	4.5	4.9	1.4	3.8	3.4	5.2	50	2.7	1.9
Value	11,2	0,0	10,4	7,5	7,5	14,4	26,6	10,4	27,0	14,7	14,0	30,4	34,0	36,4	300	27,0	19,0

Performance Scale

PERFORMANCE INDICATOR 540,5 /1000

Figure 6.4: The Objectives Matrix completed from the information in Table 6.4

- ➪ Dentist identifies strong and weak performance criteria of the clinic concerned.
- ➪ Dentist set objectives and strategies for future.
- ➪ Submits the report to the Dental Officer in charge of the dental clinic.
- ➪ Dental Officer in charge of dental clinic receives the Objectives Matrix reports of all the dentists working in the dental clinic under his management.
- ➪ Dental Officer in charge of dental clinic compiles a summary for the dental clinic.
- ➪ Dental Officer in charge identifies strong and weak areas.
- ➪ Dental Officer in charge sets objectives and strategies for the future.
- ➪ Dental Officer in charge gives feedback and guidance to dentists working in the clinic.
- ➪ Dental Officers in charge of dental clinics submit the summary reports of the different clinics to the Staff Officer Oral Health of the medical command concerned.

7.2. Medical Command level

- ➪ Staff Officer Oral Health receives the Objectives Matrix reports of all the dental clinics under his management.
- ➪ Staff Officer Oral Health compiles a summary for all the dental clinics in the medical command concerned.
- ➪ Staff Officer Oral Health identifies strong and weak areas of his/her command.
- ➪ Staff Officer Oral Health sets objectives and strategies for the future.
- ➪ Staff Officer Oral Health gives feedback and guidance to the dental officers in charge of clinics.
- ➪ Staff Officer Oral Health submits medical command summary report to the Director Oral Health.

7.3. Headquarters level

- ➪ The Director Oral Health receives summary reports from the Staff Officers Oral Health in all the medical commands.
- ➪ The Director Oral Health compiles a summary for all the medical commands.
- ➪ The Director Oral Health identifies strong and weak areas for the total Oral Health Service.
- ➪ The Director Oral Health sets objectives and strategies for the future.
- ➪ The Director Oral Health gives feedback and guidance to the Staff Officers Oral Health of the medical commands.

8. Summary

In Chapter 6 the planning, development and implementation of the Objectives Matrix were discussed. The first steps of the planning and development were to train and commit senior management and dental officers rendering the service to the population of the SADF.

Thereafter, the Objectives Matrix was developed by developing a mission statement for the Oral Health Service in total, establishing the aim for the different medical commands, determining the objectives for the medical commands, and finally developing key performance areas and performance criteria to measure performance accordingly. The final Objectives Matrix was presented and a reporting system to ensure accountability was proposed.

The evaluation of the Performance Measurement System is discussed in Chapter 8.

CHAPTER 7

EVALUATION OF THE PERFORMANCE MEASUREMENT SYSTEM

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CHAPTER 7

EVALUATION OF THE PERFORMANCE MEASUREMENT SYSTEM

1. Introduction

The planning, development and implementation of the Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS were deliberated in Chapter 6. In this chapter the evaluation of the Objectives Matrix is discussed.

The science of performance appraisal is directed towards two goals, namely to create a measure that accurately assesses the level of an individual's job performance and to create an evaluation system that will advance one or more operational functions of an organization (Milkovich and Wigdor, 1991, p 45). The Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS is thus evaluated by firstly evaluating the measurement system *per se*, secondly the impact of the system, and finally the development process.

The framework for Chapter 7, as well as its orientation within this dissertation is presented in Figure 7.1.

2. Evaluation of the measurement instrument *per se*

According to Wigdor and Green (1991, p 116) evaluation of the measurement instrument includes the provision of evidence that the measurements mean something. This includes the examination of the reliability and the validity of the measure. Broadly this means firstly, whether the instrument measures anything at all and secondly, whether it measures to the extent it was intended to measure. The evaluation of the measurement instrument is deliberated under the headings: [1] Reliability; and [2] Validity (Content representativeness).

2.1. Reliability

According to Wigdor and Green (1991, p 116) reliability means whether the measurement scores can be relied on, or whether they are so haphazardly variable that they cannot be said to signify anything. In practice it means that the repeated performance measurement of an individual should be about the same. The concern about reliability stems from the traditional approaches to performance appraisal where an individual is evaluated by a superior following a set of criteria with performance scales. In this instance it is likely that different superiors and even the same superior could evaluate the same individual differently.

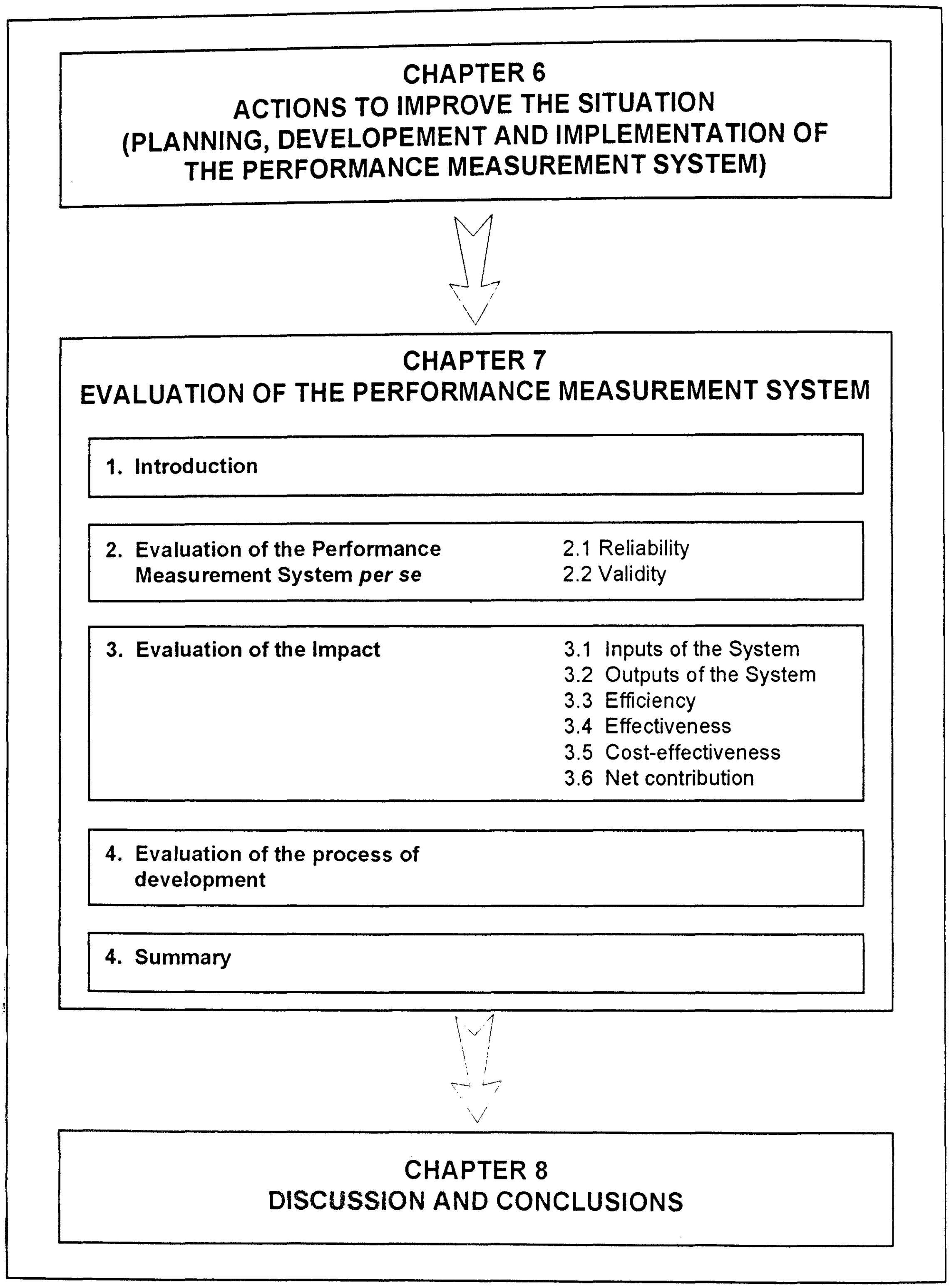

Figure 7.1: The conceptual framework and the orientation of Chapter 7 within the dissertation

The Performance Measurement System of the Oral Health Service of the SAMS is not influenced by personal views and subjectivity. The final performance score is calculated from a set of dental (DASA) codes recorded on the mainframe dental information system. Repeated performance appraisals done for a specific individual for the same appraisal period would thus be exactly the same. It is concluded that the Performance measurement system of the Oral Health Service of the SAMS is 100 percent reliable.

2.2. Validity (Content representativeness)

According to Milkovich and Wigdor (1991, p 57) validity is a technical term that has to do with the accuracy and relevance of measurements. Validity of performance appraisals is a critical measure to managers, because legal challenges should be withstood on the basis of validity. Content representativeness is also called *content validity*. The content validity of a performance measure is the extent to which the content of the measure represents the tasks and required performance of the entire job (Wigdor and Green, 1991, p 129). The development process for the Objectives Matrix included the identification of Key Performance Areas, which obey the 20:80 rule. These Key Performance Areas are thus representative of 80 percent of the work to be done to fulfil the objectives of the Oral Health Service of the SAMS. It is concluded that the content representativeness of the Performance Measurement System of the Oral Health Service of the SAMS is at least 80 percent.

The reliability and validity of the Performance Measurement System (Objectives Matrix) were evaluated and found to be 100 percent and 80 percent respectively. Since the accuracy of the Performance Measurement System (Objectives Matrix) has been established the next step is to evaluate the impact of the system.

3. Evaluation of the impact

The impact of the Performance Measurement System of the Oral Health Service of the SAMS is done from a system perspective following the framework: [1] Efficiency; [2] Effectiveness; [3] Cost-effectiveness; and [4] Net Contribution. In order to be able to deliberate these four impact criteria the inputs and outputs of the Performance Measurement System (Objectives Matrix) are firstly described.

3.1. Inputs of the Performance Measurement System (Objectives Matrix)

The inputs for the Performance Measurement System (Objectives Matrix) can broadly be classified into the inputs needed during the development of the system and the inputs needed during the operational phase of the system. Table 7.1 presents the inputs needed for both development and continuation of the Performance Measurement System (Objectives Matrix).

Description	Units	Cost / Unit	Total Cost
DEVELOPMENT COST			
First work session (12 Dental staff officers)	12 hours	40,23	482,81
Medical command work sessions: (5 session of 3 hours for a total of 65 dental officers)	975 hours	34,63	33 766,23
Final work session (12 Dental staff officers)	72 hours	40,23	2 896,56
INFO-Plan Development cost	200 hours	87,00	17 400,00
DEVELOPMENT COST			**54 545,60**
OPERATIONAL COST			
Processing cost		142,00	142,00
Printouts	140 pages	0,15	21,00
Time to complete Obj Matrix (for 65 dental officers)	6 hours	34,63	207,78
OPERATIONAL COST/MONTH	65 indiv	5,70	**370,78**

Table 7.1: Inputs for the Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS quantified in 1993 prices.

It is calculated from Table 7.1 that the input cost per individual per month is R26,21 according to 1993 prices. This cost per individual per month is calculated by spreading the development cost over a five year period at an interest rate of 16,5 percent per annum between 65 individuals and adding to this development cost per individual per month (R20,51) the operational cost per individual per month (R5,70). Having established the inputs of the Performance Measurement System (Objectives Matrix) in monetary terms the discussion moves to the quantification of the outputs.

3.2. Outputs of the Performance Measurement System (Objectives Matrix)

The output of the Performance Measurement System (Objectives Matrix) is defined as the effect the Objectives Matrix had on the performance of the Oral Health Service of the SAMS. This output is described according to the 17 criteria of, as well as the total performance according to the Objectives matrix. The change in performance one year after implementation concerning the 17 criteria and the total performance is indicated in Table 7.2.

Criterion No	Performance Level at Implementation	Performance Level after one year	Percentage change
1	3,0	3,70	23,67
2	3,0	3,62	20,67
3	3,0	3,52	17,33
4	3,0	4,30	43,33
5	3,0	3,17	5,67
6	3,0	1,80	-40,00
7	3,0	6,83	127,67
8	3,0	4,84	61,33
9	3,0	5,37	79,00
10	3,0	3,16	5,33
Effectiveness (Oral health promotion)	**3,0**	**4,03**	**34,33**
11	3,0	4,73	57,67
12	3,0	5,13	71,00
13	3,0	5,62	87,33
14	3,0	5,51	83,67
Quality of Service	**3,0**	**5,25**	**75,00**
15	3,0	4,49	49,67
16	3,0	6,92	130,67
17	3,0	6,32	110,67
Efficiency of Service	**3,0**	**5,91**	**97,00**
Total Performance	**300,0**	**452,40**	**50,80**

Table 7.2: Increase in the performance of the Oral Health Service of the SAMS measured according to the 17 criteria and total performance calculated in the Objectives matrix

The percentage increase per criterion and total performance is illustrated in Figure 7.2.

The impact of the increase/decrease in the different performance criteria is deliberated next.

3.2.1. Number of oral hygiene instructions and/or prophylaxis on children / Number of children visits x 100

This Performance criterion increased with 23,67 percent per month within one year after implementation. It is difficult if not impossible to quantify the impact this increase had on the oral health of the population. The increase of

23,67 percent implies that approximately 900 more children per month than before are receiving oral hygiene instructions and/or prophylaxis.

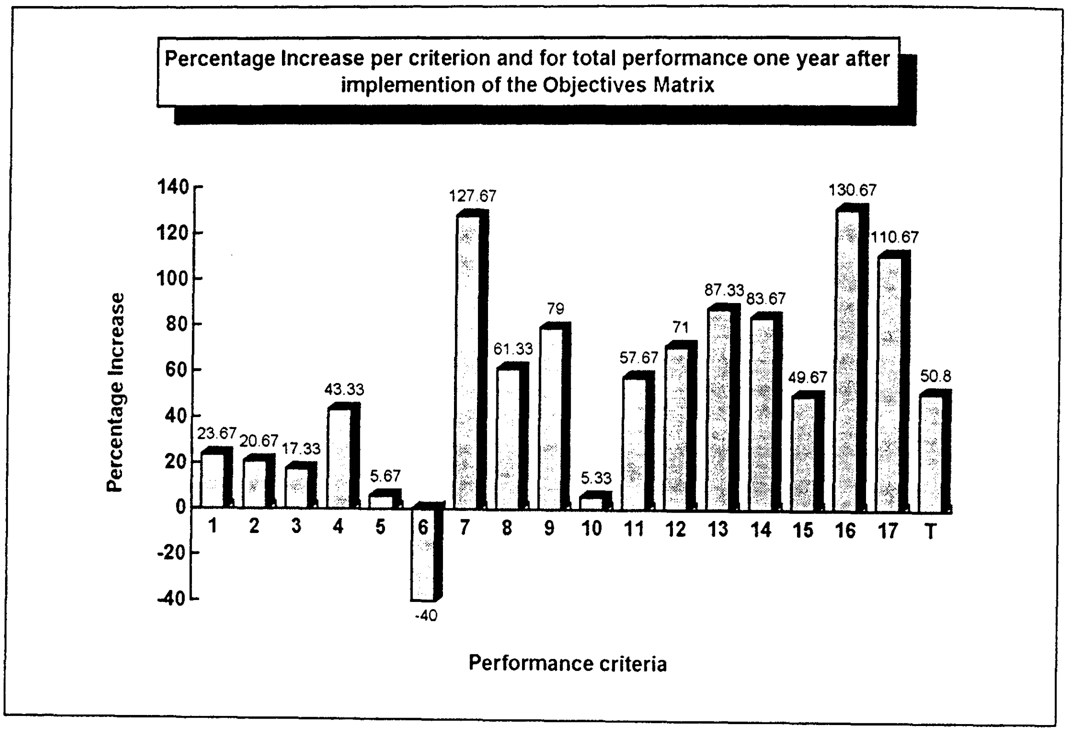

Figure 7.2: An illustration of the percentage increase in performance according to the 17 performance criteria as well as the total.

3.2.2. Number of fissure sealants done on children / Number of restorations done on posterior teeth of children x 100

This Performance criterion increased with 20,67 percent per month within the first year after implementation. This implies that 174 more fissure sealants have been done than in the past, which will reduce the number of posterior restorations needed from 27 per month after one year to 109 per month within five years (see benefit-to-effort ratio of fissure sealants in Chapter 5, Table 5.10). A saving of R405,00 per month after one year and R1 635,00 per month after five years at approximately R15,00 per filling is calculated.

3.2.3. Number of oral hygiene instructions and/or prophylaxis on adults / Number of adult visits x 100

This Performance criterion increased with 17,33 percent per month. This implies that 473 more adults per month have received oral hygiene instructions and/or prophylaxis than one year prior to the evaluation. According to Rossouw (1989, Unpublished) 11,14 percent of the adult population had periodontal pockets 4 mm and deeper, and therefore needed specialized periodontal treatment. If the risk in these 473 adults per month would only be 50% of that recorded by Rossouw then 26 of these adults would probably develop periodontal pockets needing periodontal surgery. This implies a potential saving of R3 900,00 per month.

3.2.4. Number of plastic restorations / Number of visits x 100

This Performance criterion increased with 43,33 percent per month within the first year after implementation. This indicates a decline of 98 plastic restorations per month, giving a saving of at least R1 470,00 per month.

3.2.5. Number of plastic restorations / Number of prosthetic replacements

This Performance criterion increased with 5,67 percent per month within the first year after implementation. This increase implies that clinicians have changed their minds in 5 out of every 1800 restorative decisions from being idealistic concerning treatment to being idealistic concerning the circumstances. This induced a saving of at least R5 335 per month.

3.2.6. Number of extractions / Number of visits x 100

This Performance criterion decreased with 40,00 percent per month. This implies an increase of 220 extractions per month. This decrease is alarming, but can probably be explained by the drastic change in the population composition of the SADF. To replace the function lost by these extracted teeth will cost the Oral Health Service of the SAMS at least R30 000,00 per month.

3.2.7. Number of emergency root canals / Number of completed root canal treatments x 100

This Performance criterion increased with 127,67 percent per month within the first year after implementation. This increase implies that 121 more teeth per month which received emergency root treatment have been followed up and the root treatment completed. This probably saves the cost to treat sepsis and the consequences thereof in the future. This projects a saving of at least R18 150 per month.

3.2.8. Number of removable prosthesis / Number of fixed prosthesis x 100

This Performance criterion increased with 61,33 percent per month within the first year after implementation. This increase implies that clinicians have changed their minds in 20 out of every 272 rehabilitative decisions from being idealistic concerning treatment to being idealistic concerning the circumstances. This induced a saving of at least R143 000 per month.

3.2.9. Number of active member visits / Number of total visits x 100

This Performance criterion increased with 79,00 percent per month within the first year after implementation. This implies that 600 more active members a month were treated than in the past, contributing in reducing the curative backlog in this population group and enhancing the readiness of the SADF workforce.

3.2.10. Number of preventive visits / Number of total visits x 100

This Performance criterion increased with 5,33 percent per month within the first year after implementation. The relatively low increase of this performance criterion is probably due to two contributing factors, namely the inability of curatively trained dentists to change their perspective on oral health care and secondly the curative demand from the population. However, as this increase is relatively small in comparison with the other performance criteria, it is still promising. This increase implies that 404 more patients per month have been exposed to primary preventive measures.

3.2.11. Number of patients completed / Number of total visits x 100

This Performance criterion increased with 57,67 percent per month within the first year after implementation. This implies that 990 more patients per month have been completed. This increase will reduce the waiting time for appointments and will also have a positive effect on patient satisfaction.

3.2.12. Number of emergency visits / Number of total visits x 100

This Performance criterion increased with 71,00 percent per month within the first year after implementation. This implies that 880 less patients needed emergency treatment per month. This indicates that the quality of the dental services increased and that the oral health status of the population increased.

3.2.13. Number of restorations replaced / Total number of restorations x 100

This Performance criterion increased with 87,33 percent per month within the first year after implementation. This implies that 648 less restorations per month have been replaced, indicating the increase in the quality of work as well as a saving of at least R9 725 per month.

3.2.14. Number of temporary fillings / Total number of fillings x 100

This Performance criterion increased with 83,67 percent per month within the first year after implementation. This increase implies that clinicians have changed their minds in 7 out of every 120 "emergency" decisions from using a temporary filling needing replacement to using a permanent filling. This induced a saving of at least R4 052 per month.

3.2.15. Monthly turnover of individual / R 30 000 x 100

This Performance criterion increased with 49,67 percent per month (in 1993 prices) within the first year after implementation. This increase implies an increase of R3600 per dentist, inducing a saving of approximately R234 000 per month for the total dental service.

3.2.16. Number of referrals / Number of visits x 100

This Performance criterion increased with 130,67 percent per month within the first year after implementation. This increase implies that clinicians have changed their minds in 6 out of every 1010 visits recorded to treat the patient himself instead of referring the patient to a specialist. This induced a saving of at least R7 188 per month.

3.2.17. (Turnover of the clinic x 1,5) / (Number of surgeries in the clinic x Turnover of the individual)

This Performance criterion increased with 110,67 percent per month within the first year after implementation. This increase implies that dentists have increased the utilization of infrastructure by 25 percent.

The output of the Performance Measurement System (Objectives Matrix) was quantified in monetary terms where possible. The discussion now moves to the evaluation of the efficiency of the Objectives Matrix.

3.3. Efficiency

The efficiency of the Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS is measured by allotting a monetary value to the inputs and outputs whenever possible. Table 7.3 presents the quantifiable outputs (described in paragraph 3.2 of this chapter) and the quantifiable inputs (described in paragraph 3.1 of this chapter) per month. An output-input (efficiency) ratio is finally presented.

Description	Cost per Item per month	TOTAL per month
OUTPUT		
PC 2	405,00	
PC 3	39 000,00	
PC 4	1 470,00	
PC 5	5 335,00	
PC 6	- 30 000,00	
PC 7	18 150,00	
PC 8	143 000,00	
PC 9	18 000,00	
PC 13	9 725,00	
PC 14	4 052,00	
PC 15	234 000,00	
PC 16	7 188,00	
TOTAL OUTPUT		**450 325,00**
INDIVIDUAL OUTPUT		**6 928,00**
INPUT		
Developmental cost	see paragraph 3.1	
Operational cost	370,78	
TOTAL INPUT		**1 703,65**
INDIVIDUAL INPUT		**26,21**
EFFICIENCY (%)		**26 433,00**

Table 7.3: Presentation of the total quantifiable outputs and inputs of the Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS, and calculation of the efficiency of the system.

The efficiency of the Performance Measurement System (Objectives Matrix) was evaluated by rating the monetary inputs of the system and the monetary outputs induced by the system. An efficiency ratio of 26 433 percent was calculated. This efficiency ratio means that for every one rand invested in the Objectives Matrix R265 were saved.

The savings in rand (at 1993 prices) amount to approximately R448 622 per month. If there was a linear relationship between the performance measured by the Objectives Matrix on the one hand, and cost savings and percentage efficiency on the other hand (which is definitely true within a certain range) it could be concluded that for every one point increase in performance according to the Objectives Matrix the Oral Health Service of the SAMS saved R2 971,00 and the total service was 0,2 percent more efficient.

The effectiveness of the Performance Measurement System (Objectives Matrix) is discussed next.

3.4. Effectiveness

According to Hitchins (1992, p 93) effectiveness can be evaluated by combining measures of the degree to which a system's emergent properties meet - or fail to meet - an ideal. The effectiveness of the system is evaluated under the three headings, as proposed by Hitchins (1992, p 93): [1] Contribution to the containing systems' objectives; [2] Co-operation with sibling systems; and [3] Harmony of contained systems. Figure 7.3 illustrates a possible diagram of the Performance Measurement System (Objectives Matrix), with it's contained systems, it's sibling systems and it's containing systems.

The contribution of the Performance Measurement System (Objectives Matrix) to the objectives of the Oral Health Service of the SAMS is firstly deliberated.

3.4.1. Contribution to the containing systems' objectives

Figure 7.3 illustrates that the Performance Measurement System (Objectives Matrix) is contained by the Oral Health Service of the SAMS and on a higher level the South African Medical Service *per se*. The development of the Performance Measurement System (Objectives Matrix) followed the guidelines of mission, aim, goal objectives, key performance areas and finally performance criteria to measure the performance in every key performance area. The main objective of the Performance Measurement System

(Objectives Matrix) was to measure and increase performance regarding the effectiveness (oral health promotion), the quality of services rendered (including patient satisfaction), and the efficiency of the dental service. The effectiveness of the Performance Measurement System (Objectives Matrix) is evaluated according to the aforementioned criteria as well as self-care, availability, accessibility, acceptability, continuity and adaptability.

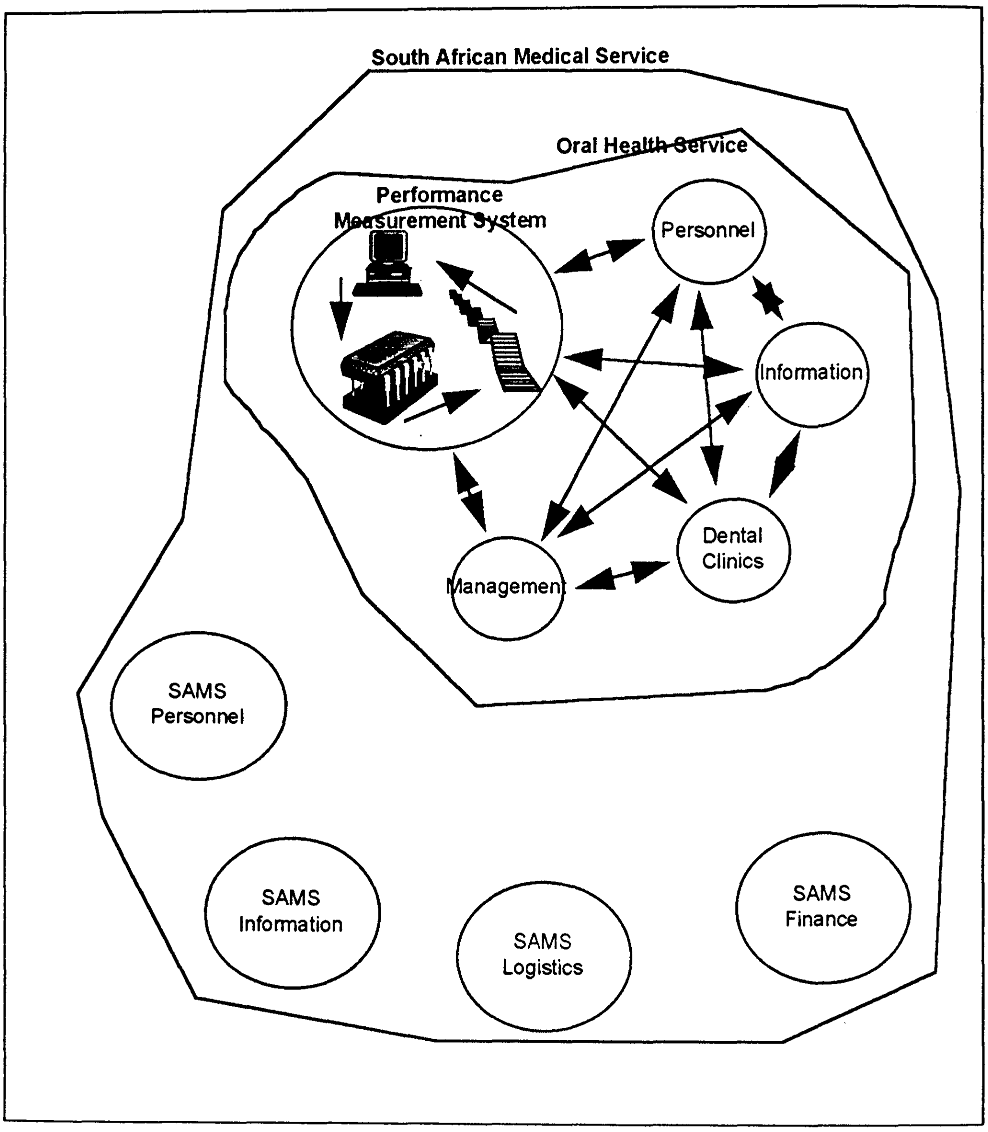

Figure 7.3: The Performance Measurement System (Objectives Matrix) with it's siblings, contained and containing systems.

3.4.1.1. *Oral health promotion (Effectiveness of the Dental Services)*

Oral health promotion is measured by the first ten criteria of the Objectives Matrix. The performance level increased from an average of 3 to an average of 4,03 (34,33 percent) within one year after implementation.

3.4.1.2. Quality of care

The quality of care is measured by criteria 11 to 14. The average of these criteria increased from a level of 3 to an average of 5,25 (75,00 percent) within one year.

3.4.1.3. Efficiency of dental service

The efficiency of the dental service is measured by the last three performance criteria of the Objectives Matrix. The efficiency of the dental service increased from an average of 3,0 to 5,91 (97,00 percent) within one year after implementation.

3.4.1.4. Self-care

The impact of the dental services on self-care by the SADF population probably relates to the preventive orientation of the service providers. This preventive orientation is measured by four criteria on the Objectives Matrix (Performance criteria 1, 2, 3 and 10). The average performance level of these four performance criteria increased from 3,0 to 3,5 (16,67 percent).

3.4.1.5. Availability and Accessibility

The availability and accessibility of the dental service are measured by performance criteria 9, 11, 12 and 14. The average performance of these four criteria increased during one year from 3,0 to 5,19 (73,00 percent).

3.4.1.6. Acceptability

The acceptability of the Oral Health Service of the SAMS is measured by performance criteria 9 through 14. The performance of the criteria increased from 3,0 to 4,83 (61,00 percent) within one year after implementation.

3.4.1.7. Continuity

The main problem in delivering a continuous service is the relatively high personnel turnover. The development of this Performance Measurement System (Objectives Matrix) developed a feeling of ownership and belonging which will possibly have a positive effect on the personnel turnover. The ownership of the dental personnel is illustrated in the overall increase (50,8 percent) measured by the Objectives Matrix (from an average of 300 to 452 points). The exact effect of the Performance Measurement System (Objectives Matrix) on the continuity of the system cannot be calculated.

3.4.1.8. Adaptability

The adaptability of the Oral Health Service of the SAMS is the ability of the service to adapt to and survive changes in the environment. Concerning this issue the Performance Measurement System (Objectives Matrix) is not only a measurement tool, but also a steering instrument to turn the service in the appropriate direction with the co-operation of all the team members. With this accepted, it is concluded that the Objectives Matrix changed the total service rendering paradigm of the Oral Health Service of the SAMS with 50,8 percent, indicating that the Objectives Matrix made the dental service more adaptable.

The contribution of the Performance Measurement System (Objectives Matrix) to the Oral Health Service of the SAMS is summarized in Table 7.4.

Contributing property	% Increase in effectiveness
Oral health promotion	34,33
Quality of care	75,00
Efficiency of dental service	97,00
Self-care	16,67
Availability and accessibility	73,00
Acceptability	61,00
Continuity	?50,80
Adaptability	50,80

Table 7.4: A summary of the percentage effectiveness increase of the important emergent properties of the Oral Health Service of the SAMS due to the implementation of the Performance Measurement System.

The next aspect of effectiveness discussed is the co-operation of the Performance Measurement System (Objectives Matrix) with its sibling systems.

3.4.2. Co-operation with sibling systems

The following siblings were identified (Figure 7.3): [1] Performance Measurement System (Objectives Matrix); [2] Personnel system; [3]

Information; [4] Dental clinics; and [5] Management. The co-operation between the Performance Measurement System (Objectives Matrix) and each of the other siblings is deliberated next.

3.4.2.1. Co-operation between the Performance Measurement System (Objectives Matrix) and the Personnel system

The Performance Measurement System (Objectives Matrix) provides the dental personnel system with information on their own performance. This self-evaluation leads to the setting of personal higher objectives and motivation to satisfy these personal objectives, which close the feedback circle and increase performance.

3.4.2.2. Co-operation between the Performance Measurement System (Objectives Matrix) and the Dental information system

The Dental Information system provides the Performance Measurement System (Objectives Matrix) with the data needed to do the performance calculations. The Objectives Matrix generates a higher productivity on the operational level which is recorded by the Dental Information System.

3.4.2.3. Co-operation between the Performance Measurement System (Objectives Matrix) and the Dental clinics

The Performance Measurement System (Objectives Matrix) measures the performance of the dental clinics regarding their service to the population of the SADF. The dental clinics are enabled to direct their output in co-ordination with the needs of the population.

3.4.2.4. Co-operation between the Performance Measurement System (Objectives Matrix) and the Management system

The Performance Measurement System (Objectives Matrix) provides the Management System with valuable management information regarding the emergent properties of the dental service. Calculated and quantified decisions are possible and personnel evaluations are objective and unbiased.

The co-operation between the Performance Measurement System (Objectives Matrix) and its siblings were discussed. It is concluded that the Objectives Matrix was effective in this regard. The final step of the effectiveness evaluation process is to evaluate the harmony of the systems contained within the Performance Measurement System.

3.4.3. Harmony of contained systems.

The systems contained are mainly the input system, the processing system and the output system. The input system is actually recording data for the mainframe dental information system. The mainframe dental information system supplies the data to the processing unit, which calculates the value of all the variables needed, as well as the scores of the different performance criteria and the total performance of every individual rendering an oral health service. Individuals then request the report and the report is printed by the output system at the location requested by the individual.

The effectiveness of the Performance Measurement System (Objectives Matrix) was evaluated following the framework of: Contribution to the containing systems' objectives; Co-operation between the sibling systems; and Harmony of contained systems. It is concluded that the Performance Measurement System (Objectives Matrix) is an effective system.

The cost-effectiveness of the Performance Measurement System (Objectives Matrix) is evaluated next. It differs from efficiency as far as that it includes all the emergent properties whether they are quantifiable in monetary terms or not.

3.5. Cost-effectiveness

According to Hitchins (1992, p 95) cost-effectiveness seeks to maximize "value for money", by maximizing the ratio of effectiveness to cost. Cost-effectiveness can thus be seen as "valued emergent properties per cost" (Hitchins, 1992, p 95). Hitchins (1992, p 96) proposed a process to evaluate cost-effectiveness namely: [1] Potential solutions are generated; [2] Each solution's effectiveness is valued according to the same set of criteria; [3] The cost for each solution is determined; and finally [4] The effectiveness and cost is ratioed - the highest ratio indicates the preferred solution.

In this case the options for the Oral Health Service of the SAMS were to choose between a delivery system with a Performance Measurement System (Objectives Matrix) or without a Performance Measurement System (Objectives Matrix). Table 7.5 evaluates these two options according to the overall performance calculated by the Objectives Matrix, the costs and the cost-effectiveness ratios.

	Without Objectives Matrix	With Objectives Matrix
Effectiveness	300,00	452,40
Cost	*1 000 000,00	*1 001 704,00
Ratio (% x 1000)	30,00	45,12
* The R1 000 000,00 is an illustrative amount		

Table 7.5: Calculation of the two options available to the Oral Health Service of the SAMS.

Figure 7.4 presents the cost-effectiveness of the two options graphically.

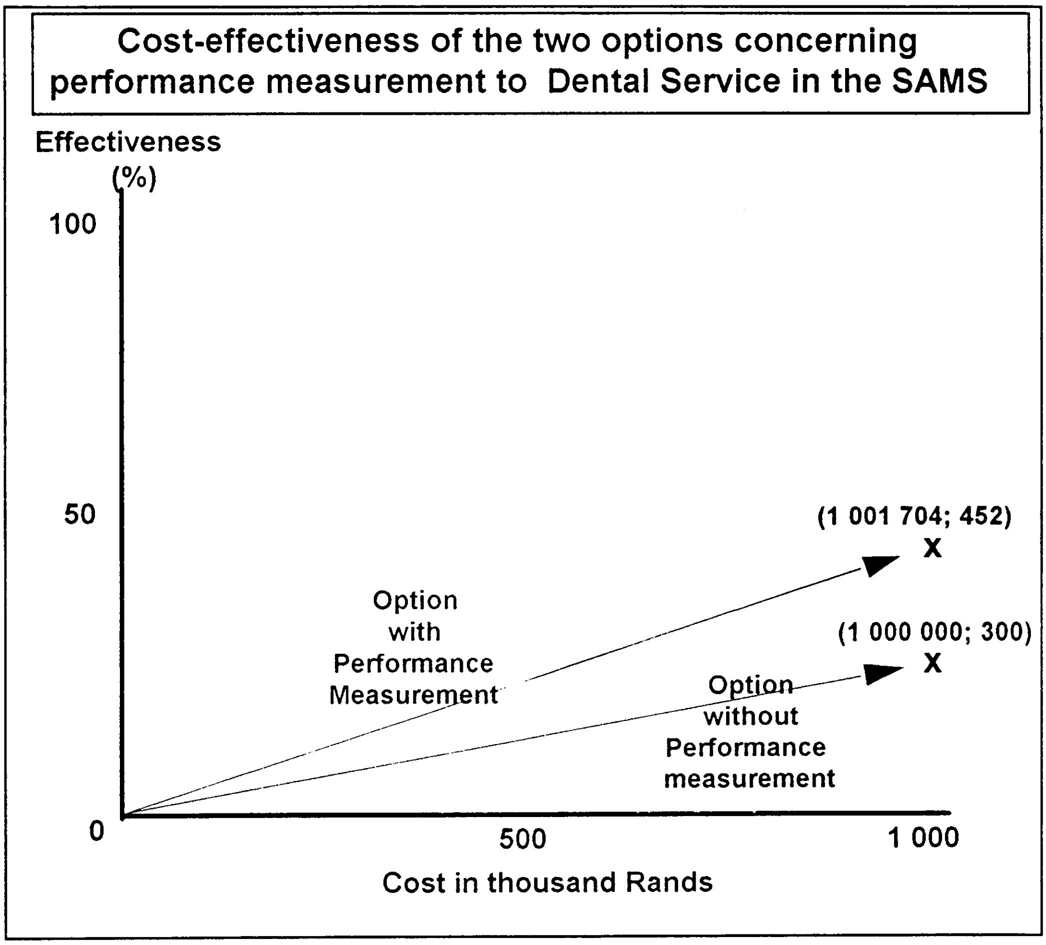

Figure 7.4: Presentation of the cost-effectiveness of the option with and the option without performance measurement (Objectives Matrix) available to the Oral Health Service of the SAMS.

It is clear from the deliberation that delivering the service with a computerized Performance Measurement System (Objectives Matrix) has a more favourable cost-effective ratio than rendering the service without it.

Finally the Net contribution of the Performance Measurement System (Objectives Matrix) is evaluated.

3.6. Net contribution

According to Hitchins (1992, p 109) the role of cost is placed into perspective by Net Contribution. Net contribution overcomes the tendency of cost-effectiveness to concentrate on the positive aspects. The net contribution process puts the positives in balance with the negatives (Hitchins, 1992, p 100). The process of net contribution follows the steps hereunder:

- ⇨ Identification of the containing system and the sibling systems contained within it, and to apportion their attribute in such a way that the containing system's requisite features are realized.
- ⇨ Evaluate the system in focus against this idealized contribution budget.

It does not make sense to evaluate the Performance Measurement System (Objectives Matrix) as a stand-alone system, because it does not have emergent properties that contribute to patient care. It was however developed to change the paradigm of the service-rendering system. To evaluate the net contribution effect of the Objectives Matrix, the service-rendering system with and without the Performance Measurement System (Objectives Matrix) is evaluated. Table 7.6 presents the sibling systems contained within the Dental Services system, as well as an idealized budgeted apportioning between the contained sibling systems (exactly the same as in Chapter 5, paragraph 2.2.7, Table 5.21).

	Contained systems				
Emergent properties	**SIF**	**A**	**B**	**C**	**D**
POSITIVE CONTRIBUTIONS	**49**	**13**	**12**	**17**	**9**
Health Promotion	65	10	10	10	5
Patient satisfaction	65	10	10	10	5
Self-care	60	15	5	15	5
Availability & Accessibility	45	15	10	15	15
Acceptability	45	15	10	15	15
Continuity	30	20	15	25	10
Adaptability	30	10	25	30	5
NEGATIVE CONTRIBUTIONS	**47**	**31**	**6**	**8**	**8**
Capital cost	75	5	10	5	5
Operating cost	30	55	5	5	5
Human behaviour (dentists)	45	30	5	10	10
Dentist compensation	40	35	5	15	5
NET CONTRIBUTION	*2*	*-18*	*6*	*9*	*1*

SIF	=	System in focus (Service-rendering systems)
A	=	Personnel system
B	=	Information system
C	=	Management system
D	=	Logistical system

Table 7.6: Sibling contribution budget in the Oral Health Service of the SAMS

Table 7.7 presents the evaluation of the two options to render a dental service, namely without the Performance Measurement System (Objectives Matrix) and with the Performance Measurement System (Objectives Matrix)

	Service Delivery System		
Emergent properties	**Idealized**	**Without Performance Measurement**	**With Performance Measurement**
POSITIVE CONTRIBUTIONS	**49**	**37**	**53**
Health Promotion	65	35	48
Patient satisfaction	65	65	81
Self-care	60	30	35
Availability & Accessibility	45	35	60
Acceptability	45	45	72
Continuity	30	30	30
Adaptability	30	20	45
NEGATIVE CONTRIBUTIONS	**47**	**48**	**42**
Capital cost	75	75	75
Operating cost	30	30	22
Human behaviour	45	45	30
Dentist compensation	40	40	40
NET CONTRIBUTION	***2***	**-11**	**11**

Table 7.7: Evaluating the net contribution of the service-rendering system option according to the idealized values determined in Table 7.6.

According to this net contribution evaluation of the Performance Measurement System (Objectives Matrix), it is concluded that the Performance Measurement System (Objectives Matrix) had a positive net contribution to the Oral Health Service of the SAMS as a contained system. It is again stated that if all systems were evaluated using Net contribution, and if only positive solutions were accepted, then a hierarchy of net positive systems contained within net positive systems should develop (Hitchins, 1992, p 109).

The impact of the Performance Measurement System (Objectives Matrix) was evaluated by using efficiency, effectiveness, cost-effectiveness and Net contribution systems techniques. The efficiency was found to be 26 433 percent, the effectiveness was an average of 50,8 percent higher than without the system, the cost-effective ratio was

45,12 in comparison with the 30 of the service without the Objectives Matrix and the Net Contribution was found to be highly positive.

The final step to evaluate the process through which the Performance Measurement System (Objectives Matrix) was developed.

4. Evaluation of the process of development

The process followed during the development of the Performance Measurement System (Objectives Matrix) can possibly be evaluated by measuring the compliance of the dental providers with the system. The compliance is measured by the change in dental care attitude, which is indicated by the increase in overall performance from 300 to 452 points within one year. It is concluded that the developmental process was effective.

5. Summary

The Performance Measurement System (Objectives Matrix) was evaluated following the outline of: [1] Evaluation of the measurement system *per se*; [2] Evaluation of the impact of the system; and [3] Evaluation of the development process. The performance measurement system *per se* was found to be reliable and valid. The impact of the system was found to be efficient, effective, cost-effective and it made a positive net contribution to the Oral Health Service of the SAMS. Finally it is concluded that the development process was effective.

CHAPTER 8

DISCUSSION AND CONCLUSIONS

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CHAPTER 8

DISCUSSION AND CONCLUSIONS

1. Introduction

The results of the study are discussed in this chapter. Where possible comparisons with other studies are deliberated, old questions are seen in a new light, and some new questions are posed. Conclusions are drawn at the end of every discussion to help the reader follow the argument. Finally the chapter is summarized and the main conclusions are stated.

The framework for Chapter 8 as well as its orientation in the dissertation is presented in Figure 8.1.

2. Discussion and conclusion

The results of the study are discussed and conclusions are drawn under the headings: [1] Fissure sealants and Preventive System; [2] The Performance Measurement System (Objectives Matrix); and [3] The systems approach. The results concerning the fissure sealants and Preventive System are deliberated first.

2.1. Fissure sealants and the Preventive System

The fissure sealants and the Preventive System are deliberated in two main sections namely, planning and implementation, and evaluation.

2.1.1. Planning and Implementation

The planning of the Preventive System was done according to the guidelines proposed by Kerzner (1992, p 83). This project or systems approach follows the following dynamic steps: [1] It determines the existing needs or potential deficiencies of existing systems; [2] It provides initial guidance to overcome existing or potential deficiencies; [3] It determines feasibility, acceptability and vulnerability of the oral health project or programme; [4] It examines alternative options; [5] It firmly identifies all human and non-human resources before the start of the project; [6] It evaluates the cost of the project before implementation; [7] It describes what the system will do and how it will interact with other existing systems; [8] It considers ethical aspects; [9] It exactly describes the time needed for implementation; [9] It includes the management of all human and non-human resources; [10] It evaluates continuously; and [11] It implements through the systems phenomena of input ⇨ process ⇨ output.

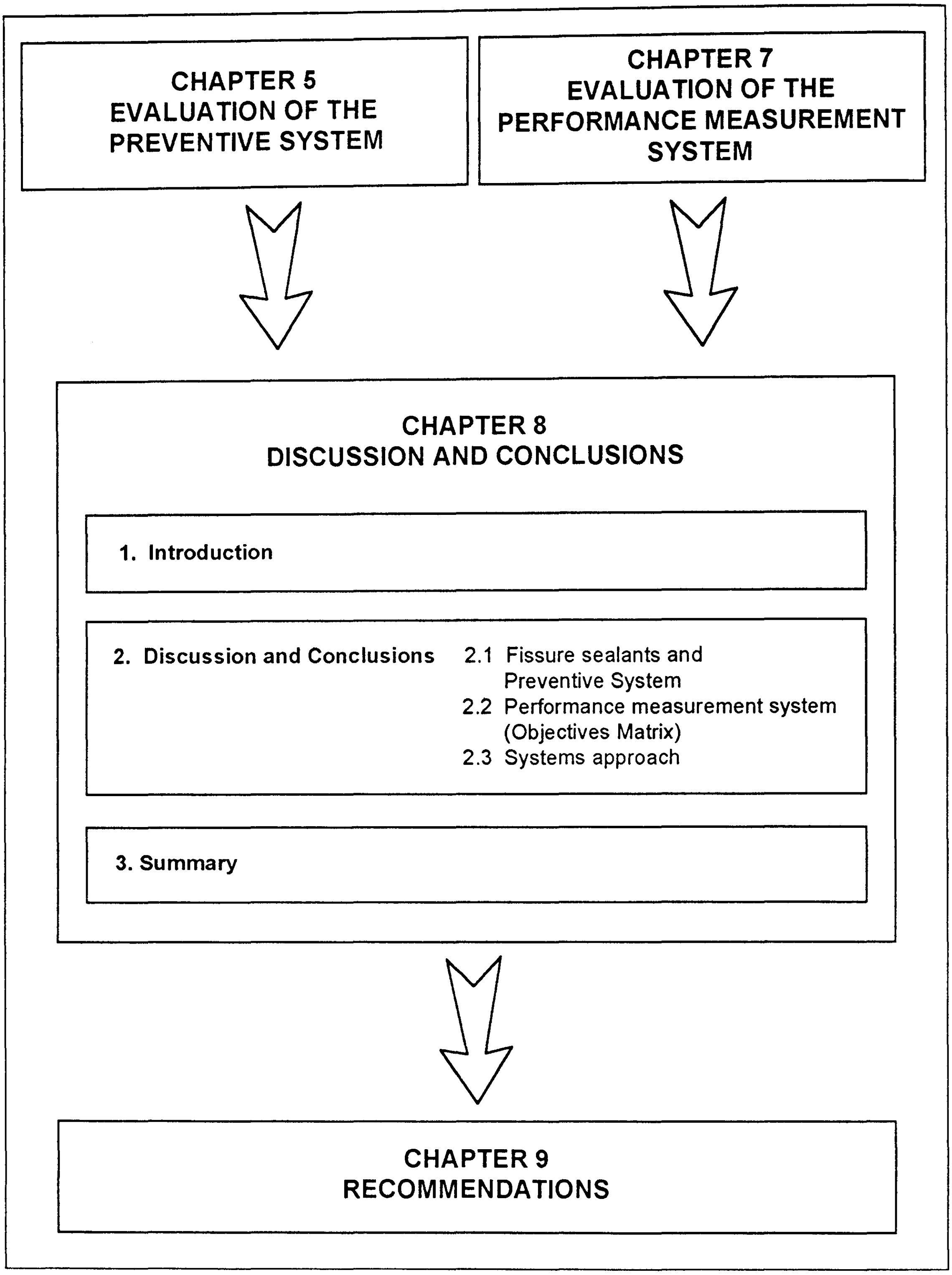

Figure 8.1: The conceptual framework and orientation of Chapter 8 within the dissertation

The planning process proposed by the WHO (1980, p 5-21) follows the steps of: [1] Situation analysis; [2] Measurable goals; [3] Manpower production goals; [4] Monitoring and evaluation; [5] Buildings, equipment, and supplies; and [6] Costing of the plan. This WHO approach to planning is static, it does not evaluate the feasibility, acceptability and vulnerability of the plan before implementation, it does not evaluate available options, it accepts the fact that actual costs will almost always exceed the planned budget, it does not describe how the planned service will interact with other systems, it leaves a lot of essential aspects to the planners' own common sense, like ethical aspects and operational management of personnel and logistics, and finally it plans to evaluate only in five year intervals.

It is concluded that the WHO approach seems to be static and it pretends that health services operate in relative isolation, with almost no economical realities. In contrast with this the project planning approach is dynamic, it acknowledges and plans for interactions with other systems, and, most important, it intends to optimize the satisfaction of needs with the reality of scares resources.

2.1.2. Evaluation

The discussion on the evaluation of the fissure sealants and the Preventive System followed the guidelines indicated in the dental literature and then moved to a higher systems level.

2.1.2.1. Effectiveness

Effectiveness is firstly discussed according to the dental literature whereafter it is enlightened by the systems perspective on effectiveness.

2.1.2.1.1. Clinical retention

The clinical retention of the fissure sealants in this study was 98,75 and 97,04 percent after one and two years respectively. It compares extremely favourably with other reported studies (see Appendix B). Moola, Dhansay and Bawa (1988) reported 45 and 55 percent clinical retention after three and eighteen months respectively in a similar field setting as this study. Moola, Dhansy and Bawa claimed that the use of light cured sealants with the shadow effect on the distal pit of maxillary molars could have caused their low retention rates. The current study also used light cured sealants and the retention rate of 97 percent after two years is explained by the high training standard of the oral hygienists and the continuous attention to cure the sealant in the distal fossa of maxillary molars.

In health organizations, evaluating the clinical retention of fissure sealants does not indicate the effectiveness of the sealant, because the goal of health services is to reduce disease and promote health, and not to have retention of sealants. It does however evaluate the sealant application process. Low retention rates would thus suggest problems with the clinical technique, the material used and/or the training, motivation or ability of personnel.

It is thus concluded that clinical retention does not evaluate sealant effectiveness, but rather the effectiveness of the clinical application process, being influenced mainly by the training quality of field personnel.

2.1.2.1.2. Occlusal caries reduction

The occlusal caries reduction of this study was 84,9 percent after two years. The difference between this result and the result of Rossouw (1990, p 11) who recorded a caries reduction rate of 65 percent, is explained by the higher clinical retention of this study (indicating the importance of a precise clinical application process), the use of different tooth selection criteria and the higher DMFT status of this study. It is concluded that occlusal caries reduction depends on the clinical retention of the sealant and effective tooth selection criteria.

In health services, occlusal caries reduction is a valuable tool to indicate the effectiveness of fissure sealants. The rate is useful to quantify the outputs in determining the efficiency of a health system.

2.1.2.1.3. Caries status of sealed teeth

The caries status of sealed teeth in this study was calculated as 0,5 and 0,85 percent after one and two years respectively. Weintraub (1989, p 327) reported the caries status of sealed teeth from 16 studies. The mean caries status of sealed teeth from these studies were 4 and 7 percent one and two years after application. The study of the Oral Health Service of the SAMS performs above average comparing to these results, especially if taken into consideration that these reported studies were predominantly clinic-based. Weintraub (1989, p 327) concluded that these caries status results indicated the need for re-application of sealants lost. This conclusion is however not justified as it is not known what the clinical retention of the different studies was.

The criterion "caries status of sealed teeth" does not evaluate the effectiveness of a sealant programme for a health service. In conjunction with clinical retention it probably indicates the selectiveness of the tooth selection criteria.

2.1.2.1.4. Re-application rates

The re-application rate of this study was calculated as 0,75 and 2,11 percent after one and two years respectively. In comparison with studies reported in the dental literature (see Appendix B) the study of the Oral Health Service of the SAMS again excels according to this criterion. The low re-application rate was possibly due to the high clinical retention.

The re-application rates does not evaluate effectiveness from a health service perspective. It does however (as did clinical retention) evaluate the clinical application process, and acts as an input to evaluate the efficiency of the service or system.

2.1.2.1.5. Reduction of caries risk

The reduction of caries risk for the study of the Oral Health Service of the SAMS was calculated by using relative risk and attributable risk. The relative risk for the study was 1:2,392 after two years compared to the odds ratio of 1:7,5 calculated by Simonsen (1991, p 39) after fifteen years. This difference is explained by the fact that the relative risk of the study of the Oral Health Service of the SAMS will probably increase with time, and secondly the possibility that the caries prevalence in the population of the Simonsen study was higher.

The value of reduction of caries risk for health service is questionable; it can possibly play a role in managed care with risk sharing and risk management.

It is concluded that the sealant study of the Oral Health Service of the SAMS performed excellent regarding its effectiveness in comparison with studies reported in the dental literature. The problem however is that except for the evaluation of caries reduction, the criteria to evaluate effectiveness as proposed by the dental literature do not serve to evaluate effectiveness for any health service or organization. The clinical retention and re-application rates may be useful to evaluate the clinical application process. The evaluation of the clinical application process is useful because of the predominant importance of the process in the possibility of the sealant being effective. Furthermore the caries reduction and re-application rates may serve as inputs to calculate the efficiency of the system.

The discussion now moves to the evaluation of effectiveness from a systems perspective.

2.1.2.1.6. Effectiveness from a systems perspective

The effectiveness of the Preventive System of the SAMS was evaluated under the headings: contribution to the containing systems' objectives, co-operation with sibling systems and harmony of the contained systems. According to this approach the effectiveness of the Preventive System of the SAMS was calculated at 79,85 percent. To the author's knowledge, however, this is the first study of its kind in dentistry and probably also in health service, and therefore it is not possible to compare the results to previous attempts.

The approach is comprehensive; it acknowledges the principle of cybernetics in health services, and it evaluates co-operation and harmony between sibling systems and contained systems. The quantification of the contribution to the containing systems' objectives is possible, given that the organization knows where it is heading. The co-operation between siblings and harmony of contained systems could however not be quantified on a scale other than positive or negative.

It is thus concluded that the evaluation from a systems perspective is a valuable and comprehensive technique for health services. The quantification of the co-operation between siblings and the harmony of contained systems however need more research and understanding.

2.1.2.2. Economic evaluation

The discussion on the "economic evaluation" includes efficiency according to the dental literature and efficiency and cost-effectiveness from a systems view. The efficiency according to the dental literature is deliberated first under the headings: cost-effectiveness, benefit-to-effort ratio, and cost benefit analysis.

2.1.2.2.1. Cost-effectiveness

Early studies attempted to indicate the factors having an effect on the cost of fissure sealants (see Appendix B). Later studies made an effort to calculate the cost of a sealant done under different circumstances and by different oral health personnel. Only recently Elderton (1990, p 25) indicated that the cost of sealants should be compared with the improvement in health it caused.

Hartshorne and Carstens (1989, Unpublished) indicated the cost of a sealant done by an oral hygienist and a dentist respectively as R3,02 and R5,58; and the cost of an occlusal amalgam as R10,54. In the study of the Oral Health Service of the SAMS the cost of a sealant placed by an oral hygienist and a dentist was calculated as R3,21 and R6,22 respectively, while the cost of an occlusal amalgam was calculated at R15,00. The difference between these two studies is probably due to the rise in the price of materials and the higher salaries since 1989. These calculations do not, however, indicate cost-effectiveness for a health system. If the time value of money could be included with accuracy these figures could however be used to do future planning and budgeting. In conjunction with caries reduction these costs give an indication of the cost-effectiveness in relation to the health improvement it caused. These costs do not, however, include fixed costs and overheads. It is concluded that the calculation of the cost (cost-effectiveness) of sealants in health services is valuable for future planning and budgeting and the calculation of cost-effectiveness in relation to caries reduction. It is however noted that the cost does not include all the costs involved.

The cost-effectiveness of this study according to the proposal of Elderton (1990, p 250) was calculated to be R22,26 and R15,07 per unit of DMFT reduction one and two years after application. (This will probably drop to R5,55 per DMFT unit after 5 years). These results could not be compared to other results from the dental literature, but it hopefully gave the first step in the right direction. The results also serve as an input to evaluate cost-effectiveness from a systems outlook.

It is concluded that cost-effectiveness from the health improvement angle should be explored in more depth, and for a health system it could at least serve as an input to evaluate the cost-effectiveness of the system.

2.1.2.2.2. Benefit-to-effort ratio

The benefit-to-effort ratio of this study was calculated as 1:6,46 and 1:4,37 one and two years after application. This relationship possibly tends to be 1:1 after five years. In correlation with reported studies (see Appendix B) these results are excellent. The findings support the statement by Simonsen (1991, p 41) that the benefit-to-effort ratio tends to be a 1:1 relationship with an increase in age. The evaluation criterion might be of value for health services if used in conjunction with the cost of sealants and one-surface amalgams. It does however not include all benefits and all effort. It is concluded that although the benefit-to-effort ratio of the study of the Oral Health Service of the SAMS compares favourably with reported studies, and that it may serve as an input to calculate system efficiency, it does not include all efforts of and benefits for the system.

2.1.2.2.3. Cost-Benefit

Cost-benefit is probably the only evaluation criterion in the dental literature that attempts to acknowledge all benefits of the programme. It has however not been quantified yet. Although this criterion acknowledges all the output benefits it does not incorporate all the input cost. It is concluded that the cost-benefit analysis from the dental literature might be useful if all input costs for the system were calculated. The cost-benefit analysis might serve as an input to evaluate cost-effectiveness from a systems view.

The economic evaluation of the sealant project of the Oral Health Service of the SAMS was discussed according to the dental literature. It is concluded that the three analysis methods were not comprehensive enough to evaluate a health service or system. The results of these calculations might however serve as inputs to evaluate the system on a wider level. The economic evaluation of the sealant project from a systems perspective is deliberated next.

2.1.2.2.4. System Efficiency

The efficiency of the Preventive System was calculated as 126 and 191 percent after one and two years respectively. The efficiency ratio will probably increase to 534% after five years. These figures could not be compared to other studies, because to the knowledge of the author there are no similar studies in dentistry or even health care. The calculated percentages are however impressive. It is concluded that measuring efficiency from a systems perspective gives valuable information regarding the total system, but it should still be considered as imperfect as it only includes outputs and inputs quantifiable in monetary terms. There are outputs that are not quantifiable in money value, and the outputs are not necessarily effective. The criterion however calls for more research.

2.1.2.2.5. System Cost-effectiveness

The cost-effectiveness ratio of the Preventive System was calculated as 0,843 in comparison with the 0,481 of the curative option. There was again no data available to compare with these results. Cost-effectiveness from a systems view does however include all costs (inputs) and effects (outputs or emergent properties), making it a more comprehensive evaluation technique. Furthermore, in the case of cost-effectiveness the outputs should be effective. It is concluded that cost-effectiveness from a systems perspective can be a valuable tool for health services, especially in deciding between available options.

It is concluded that economic evaluations from the dental literature tend to overlook the total impact of programmes as well as the total input required to execute a programme. Evaluation from a systems view does however include all inputs and outputs, making it more effective in evaluating any programme or system. The approach does however need more research. According to this comprehensive evaluation, the preventive approach to oral health (Preventive System) performed on a much higher level than the traditional curative approach. The traditional curative approach is definitely no longer justified.

2.1.2.3. Net contribution

According to the net contribution approach to evaluating systems the Preventive System had a positive net contribution of 18 points, while the curative option had a negative net contribution of 11 points. There was again no data available to compare with these results. The approach is however valuable to evaluate a programme, a project or a system. It goes further than cost-effectiveness in the sense that it does not recognize cost as the only negative factor.

It is concluded that net contribution from a systems perspective is a somewhat complex, but extremely useful tool for the health industry. If only systems with negative net contribution (e.g. the traditional curative approach) were abolished in the past, the health industry would probably not have been in its current dilemma.

The effectiveness, the economic evaluation and the net contribution of the fissure sealants and the Preventive System were deliberated. It is concluded that the evaluation criteria from the dental literature is of little value to the manager of health services. Using the systems evaluation criteria is however promising. The Preventive System of the Oral Health Service of the SAMS was efficient, effective, cost-effective and it made a positive net contribution according to systems techniques.

2.2. Performance measurement (Objectives matrix)

The results of the Performance Measurement System (Objectives Matrix) are discussed under the headings: [1] Planning and implementation; and [2] Evaluation.

2.2.1. Planning and Implementation

The Performance Measurement System (Objectives Matrix) was planned and developed according to the guidelines set by Geyser (1986, p 6-17) and Van Aardt (1990, p 4-13). The development of personnel in productivity and supporting techniques, the participative decision making and the development of the Objectives Matrix through group discussions with the guidance of a goal or mission hierarchy prove to be an effective planning and implementation approach.

It is concluded that this study supports earlier findings that performance measurement systems should be developed with the full co-operation of the personnel concerned.

2.2.2. Evaluation

The Performance Measurement System (Objectives Matrix) was evaluated in two steps, namely the Objectives Matrix as a measurement instrument and the impact of the Objectives Matrix from a systems perspective. The evaluation of the instrument *per se* is deliberated next.

2.2.2.1. Evaluation of the measurement instrument

The Performance Measurement System (Objectives Matrix) was evaluated for its reliability and its validity or content representativeness. The reliability was found to be 100 percent and the validity 80 percent. To the knowledge of the author there are no reported results available in dental or even health care to compare these findings with. The concern about reliability is based on the subjectivity of traditional performance appraisal techniques, while the concern about validity stems from the fact that people should be evaluated according to their total job content. The Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS performed excellent in both these criteria due to the fact that it measured performance from data recorded by the personnel themselves on a mainframe database, and that the Objectives Matrix was developed by identifying Key Performance Areas which represented 80 percent of the work being done.

It is thus concluded that performance measurement with the Objectives Matrix in oral health services can be highly reliable if recorded service data are used. The validity of the Objectives Matrix is also very high if it is developed within the goal hierarchy of the organization and if key performance areas are identified correctly.

2.2.2.2. Impact of the Performance Measurement System (Objectives Matrix)

The impact of the Performance Measurement System (Objectives Matrix) was evaluated from a systems view, using efficiency, effectiveness, cost-effectiveness and net contribution analysis.

2.2.2.2.1. Efficiency

The efficiency of the Performance Measurement System (Objectives Matrix) was calculated at 26 433 percent (twenty six thousand four hundred and thirty three percent). There are no research results available to compare with these findings. It is however concluded that a well planned and implemented Objectives Matrix in oral health systems is highly efficient.

2.2.2.2.2. Effectiveness

The Objectives Matrix was 57,4 percent effective in contributing to the containing systems objectives. The co-operation between siblings and the harmony of contained systems could not be quantified, but it was positive. These results could not be compared, due to a lack of previous research. It is concluded that an Objectives Matrix is a highly effective sub-system to increase performance within oral health services. It should however be noted that the Performance Measurement System (Objectives Matrix) did not increase performance in the preventive performance criteria as effectively as it improved performance in the other performance criteria. This is probably an indication that curatively trained and oriented dental personnel do not easily change their behaviour from curative to preventive.

It is thus concluded that although the Objectives Matrix did improve the overall performance within the Oral Health Service of the SAMS with 57,4 percent, it did not change curative behaviour of dental personnel to the same degree due to the curative foundation laid during pre-graduate training.

2.2.2.2.3. Cost-effectiveness

The cost-effectiveness ratio of the Performance Measurement System (Objectives Matrix) was calculated as 45,12 in comparison with the 30,00 of the curative option. The difference is explained by the fact that the Objective Matrix improved the performance of dental personnel according to the ideal emergent properties of the Oral Health Service of the SAMS. It is thus concluded that the Objectives Matrix is a cost-effective measurement tool through the improvement of emergent properties of the contained system.

2.2.2.2.4. Net Contribution

The Delivery System (with the Objectives Matrix) of the Oral Health Service of the SAMS had a positive net contribution of 11 in comparison with the 11 point negative net contribution of the delivery system without an Objectives Matrix.

It is concluded that the Objectives Matrix made a positive net contribution of 22 points to the Oral Health Service of the SAMS, and that the Delivery system should actually be abolished if it was to be functioning without the performance measurement system.

The efficiency, effectiveness, cost-effectiveness and net contribution of the Performance Measurement System (Objectives Matrix) of the Oral Health Service of the SAMS were deliberated from a systems perspective. It is concluded that the Objectives Matrix is an efficient, effective, cost-effective and positive net contribution system. The discussion continues with the deliberation of the use of the systems approach to managing oral health.

2.3. Systems approach

The goal of this study was to apply and use system methodologies and techniques in managing oral health within the Oral Health Service of the SAMS. The deliberation lacks comparison with other studies as to the knowledge of the author the specific approach was not used in the management of oral health or health services previously. The use of the systems approach is deliberated under the headings: [1] Soft Systems Methodology; [2] Project Management; and [3] Evaluation techniques.

2.3.1. Soft Systems Methodology

The SSM of Checkland was utilized as a management framework. In comparison to the planning approach of the WHO (1980, p 5-21) the SSM was found to be comprehensive, dynamic, interactive and creative. According to Flood and Jackson (1991, p 178) the SSM allows continuous checking of new avenues of exploration and back-tracking when blind alleys are discovered, and the whole process of exploring alternative ways forward can be done consciously and rigorously. This statement is supported by this study; it is possible to continuously evaluate, and move forward and backward between the steps until a satisfactory situation (system) is found.

It is thus concluded that using the SSM is an effective management tool to problem solving and planning. The methodology does however call for more research, especially in the health industry.

The different steps of the SSM are briefly deliberated.

- ⇨ The business economic environmental scanning process is a useful, comprehensive, structured and effective information gathering process, from which a complete "rich picture" can be drawn.
- ⇨ The use of the rich picture is creative and in line with contemporary thinking about problem solving.
- ⇨ The generation of systems to improve the situation, with the use of the CATWOE analysis and conceptual models, is effective in the development of systems that could contribute to the emergent properties of an ideal system.

2.3.2. Project management (Systems life cycle)

The use of a systems approach to project management is discussed in short.

- ⇨ The use of the system's life cycle in the conceptualization, planning and implementation of oral health projects is comprehensive and effective.
- ⇨ The determination of the feasibility, acceptability and vulnerability according to Cooke and Slack (1984, p 283) seems to have a predictive value concerning the success of a project.
- ⇨ The selection of project options with the use of a weighting option according to the feasibility, the acceptability and the vulnerability of each option is effective.
- ⇨ The use of diagrams during the planning and implementation of an oral health project is essential.
- ⇨ The use of the basic systems phenomena, namely input ⇨ process ⇨ output is a useful and comprehensive framework to plan, implement and evaluate.

It is concluded that managing oral health programmes as projects (from a systems perspective) is effective and efficient.

2.3.3. Evaluation techniques

The use of evaluation techniques according to a systems view is much more comprehensive and realistic for real world situations and organizations than traditional experimental approaches (see discussion under paragraph 2.1.2 of this chapter). There seems to be a system hierarchy in the evaluation process according to system techniques (see Figure 8.2).

Regarding the evaluation criteria proposed by system thinkers the following discussion.

- Evaluating efficiency from a systems view is an internal look at the system, ratioing inputs and outputs (the outputs do not need to be effective), quantifiable in monetary terms.
- Evaluating effectiveness from a systems view is evaluating the system more comprehensively, and evaluating firstly the emergent properties of the system, secondly the co-operation of sibling systems and finally the harmony of contained systems. This approach acknowledges and evaluates the interaction and relationship between a system and its environment, between the system and its siblings, and the systems contained within the system.
- Cost-effectiveness is a justifiable quantitative technique to evaluate the system's effectiveness in monetary terms. It is very useful in choosing between alternatives.
- Net contribution is a complex, but valuable technique to comprehensively evaluate any system. If only net positive systems are maintained health systems will excel in promoting and achieving health.

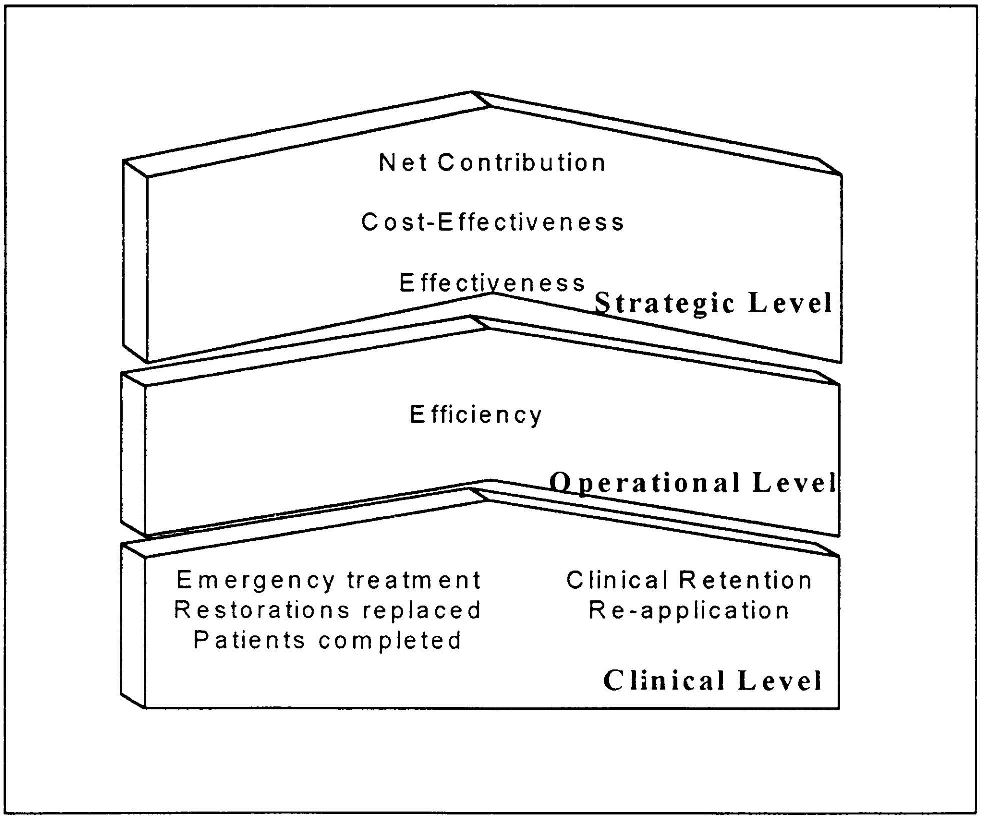

Figure 8.2: A possible system hierarchy of the different evaluation criteria.

It is concluded that adopting a systems approach to the management of oral health (planning, implementation and evaluation) is a valuable root through which health systems can improve their impact on the health status of their populations.

3. Summary

The results of the study were discussed and conclusions were drawn under the headings: [1] Fissure sealants and Preventive System; [2] Performance Measurement System (Objectives Matrix); and [3] The Systems approach. It is finally concluded that:

- The Preventive System was efficient, effective, cost-effective and had a positive net contribution.
- The Performance Measurement System (Objectives Matrix) was efficient, effective, cost-effective and made a positive net contribution.
- The use of the systems approach to the management of oral health was effective and efficient.

CHAPTER 9

RECOMMENDATION

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CHAPTER 9

RECOMMENDATION

1. Introduction

In Chapter 8 the results of the study were discussed and conclusions were drawn. In this chapter the recommendations, following the discussion and conclusions in Chapter 8, are stated. Recommendations regarding the systems approach are stated first, and then the recommendations regarding the Preventive System (Project) and Performance Measurement System.

2. Systems approach

Concerning the use of a Systems Approach the following is recommended:

- ⇨ That health organizations should cease seeing themselves as rendering a curative treatment-product, but rather regard themselves as systems, producing an output - health or oral health - which includes the treatment of disease.
- ⇨ That health organizations should cease managing sickness, and start to manage health as an output of their system.
- ⇨ That health organizations adopt a systems approach to the management of health.
- ⇨ That health organizations should use a Soft Systems Methodology to solve problems and plan services. (For example the SSM was found to be comprehensive, dynamic, interactive and fostered creativity).
- ⇨ That health services should get involved in systems research and develop a SSM for health systems in particular.
- ⇨ That health organizations should terminate the WHO planning approach which is static, isolated and discarded from any economical realities. A dynamic, interactive optimizing systems approach is proposed.
- ⇨ That health systems should be evaluated according to systems criteria, as this is probably the only way through which the impact of the system on the health status of the target population can be assessed and improved.
- ⇨ That health service get involved in operational research regarding the systems evaluation criteria. The concepts are promising, but improved quantification of performance will benefit all.

- That the Oral Health Service of the SAMS defines it own contribution balance, in co-operation with the total dental team, from where the net contribution of contained systems can be evaluated.
- That systems that do not have a positive net contribution should be abolished by its stakeholders.
- That the SAMS and the University of Pretoria should explore the possibility of establishing a centre for health systems research and management.

3. Fissure sealants and Preventive System

Concerning the use of fissure sealants and the Preventive System it is recommended that:

- Preventive Systems should be implemented without further ado; according to comprehensive systems evaluation criteria the Preventive System was found to be efficient, effective, cost-effective and made a positive net contribution to the Oral Health Service of the SAMS.
- Curatively oriented health services should be held accountable by their funders as the purely curative approach is no longer justified.
- Health organizations should cease evaluating fissure sealants, according to the dental literature. For the exception of occlusal caries reduction, cost-effectiveness, benefit-to-effort ratio and cost-benefit that might serve as inputs to evaluate the system, the evaluation criteria were developed to do laboratory research, and outside the walls of the laboratory they are probably very misleading and even dangerous.
- The Oral Health Service of the SAMS should use oral hygienist on a broader scale. Oral hygienists should be used to plan and implement preventive projects, to diagnose disease, to prevent disease and to promote oral health.

4. Performance measurement

Regarding performance measurement the following is recommended:

- That all health systems should measure performance, according to the aim (output) of the system.
- That the Objectives Matrix should be implemented in other health systems as well, as the Performance Measurement System was efficient, effective, cost-effective and made a positive net contribution to the Oral Health Service of the SAMS.
- That performance measurement systems should always be implemented with full co-operation of personnel concerned.

- ➪ That performance measurement tools should, whenever possible, be based on unbiased, highly reliable data.
- ➪ That the remuneration of oral health personnel be related to their performance, according to the Objectives Matrix.
- ➪ That the Oral Health Service of the SAMS should adjust the weights of the preventive criteria to make these criteria more important.
- ➪ That the Oral Health Service of the SAMS put some pressure on the dental faculties to change their curatively oriented pre-graduate curricula.

5. Summary

Recommendations regarding the Systems Approach, the Preventive System and the Performance Measurement System were made. In brief it is recommended that: [1] The Systems Approach to the management of oral health should be adopted; [2] Preventive Systems be implemented on a large scale; and [3] Performance should be measured.

APPENDIX A

REVIEW OF THE LITERATURE ON SYSTEMS SCIENCE

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APPENDIX A

REVIEW OF THE LITERATURE ON SYSTEMS SCIENCE

1. Introduction

Many people are talking about systems sciences but nobody quite knows what it is (Laszlo, 1972, p v). These are hard words, but they are probably true, and they are made even more harsh by the fact that few are doing anything about exploring it and making it explicit (Laszlo, 1972, p vi). Yet understanding this global view is important. If you want to change the world, you have to understand the nature of this world.

The task to change the world is not one for the cautious scholar who insists on making sure that nothing he says can be disproved or challenged. These are not times when cautious scholars can help us set our sights (Laszlo, 1972, p vii). The processes of change are too explosive and the time too short. This, however, does not mean that we must exchange fact for fancy and rigor for imagination. This is the time for controlled but bold theorizing - the raising of hypotheses to be challenged and evolved in the heat of constructive controversy.

Systems science may not only be able to assure man of a future, but it may also enable him to gain control of it (Schoderbeck *et al,* 1985, p viii). This review of the literature on systems science starts with a description of the history of science, it then proposes a reason why science shifts its sight, whereafter the rise of systems science is described. The differences between system and Newtonian science are briefly discussed, and then the deliberation moves to general system theory, hard and soft sciences, and a definition and description of systems. A classification of systems and some fundamental system concepts are discussed before the deliberation moves to the application of systems science to management. A short discussion on oral health care systems is finally presented.

2. Science in the past

Science developed as the science of Galileo and Newton (Laszlo, 1972, p 11). It could handle relatively simple relationships between forces and bodies. It presented a world picture of the universe that is reducible to such relationships in all essential aspects. Newtonian science looked upon the physical universe as an exquisitely designed giant mechanism, obeying elegant deterministic laws of motion. Until the early 1900s contemporary Western science was shaped by this mode of thinking which placed rigorous detailed knowledge above all other considerations - also called the Machine age (Laszlo, 1972, p3) or the Newtonian age. In the machine age man sought to take the world apart, to analyze its contents down to ultimate indivisible parts or elements - called reductionism. These elements were taken to be related by causal laws, laws which made the world behave like a machine (Schoderbeck *et al,* 1985, p vii). This concept left no place for the study of free will, goal seeking and purposes. These concepts were taken to be either meaningless or were relegated to the realm of pure speculation (Schoderbeck *et al,* 1985, p vii).

Most scientists are still raised on the concept of reductionism (rigorous detailed analysis) as fundamental (Hitchins, 1992, p 13). Reductionism is based on Descartes' principles of 1637 (Hitchins, 1992, p 13) :

- ⇨ Accept only that which is clear and distinct as true
- ⇨ Divide each difficulty into as many parts as possible
- ⇨ Start with the simplest elements and move by an orderly procedure to the more complex
- ⇨ Make complete enumerations and reviews to make certain that nothing was omitted

This mode of thinking is based on the belief that the human mind has a limited capacity for storing and processing information. If you know some things very thoroughly, you cannot know very many different kinds of things. This is the ideal of specialization, and it has led to the great advances in the sciences and technologies that now affect the lives of us all. Laszlo (1972, p 4) called this mode of thinking atomistic or compartmentalized specialization.

3. Why science shifts its sights

There is a problem with compartmentalized specialization. It is the tendency of patterns of knowledge to create closed bubbles in their own right. The unfortunate consequence of such speciality barriers is that knowledge, instead of being pursued in depth and integrated in breadth, is pursued in depth in relative isolation. Although compartmentalized specialization atomized our understanding it gave us a healthy respect for tested knowledge.

The specialist (atomist), pursuing knowledge in depth, looks at carefully isolated phenomena. He is interested in how one thing affects another. He can compute the effect by looking at things as separate facts connected by some causal or correlative relationship (Laszlo, 1972, p 5). We can prescribe medicines and build machines based on this knowledge.

There is however one thing these separated facts cannot tell us. That is how a number of things act together when exposed to a number of different influences at the same time. And almost everything we encounter around us contains a large number of different things and is exposed to a number of different influences.

Our mathematics are incapable of solving three-body problems (Laszlo, 1972, p5). In other words we are incapable of proceeding with the rigorous techniques of specialization for any phenomenon more complex than a helium atom. Special analysis does not give us a true mapping of many things, for real things tend to be more complex than it can handle (Laszlo, 1972, p 6).

We are, however living in a world of complexity - complexity being defined by the number of elements of the system, their attributes, the interactions between them, and the degree of organization of the system (Schöderbeck *et al,* 1985, p 5).

In the light of these thoughts, Hitchins (1992, p 7) states the following questions:

- ⇨ Can the scientific method cope with the complexities associated with human activities?
- ⇨ Can we produce hypotheses commensurate with the complexity of the system?
- ⇨ Can experiments be carried out which do not disturb the fabric they seek to study?
- ⇨ Can we manage complexity by reducing a complex whole into understandable, manageable parts?
- ⇨ Can we study parts of the society separately and join the parts together meaningfully?

From the above-mentioned thoughts a new paradigm emerged - a new way of ordering the information we already have and are likely to get in the foreseeable future (Laszlo, 1972, p 4). Contemporary science now looks at a number of different and interacting things and notes their behaviour as a whole under diverse influences.

While the specialist concentrated on detail and disregarded the wider structure which gave it context, the new scientist concentrates on structure on all levels of magnitude and complexity, and fits detail into its general framework (Laszlo, 1972, p 13). The new scientist discerns relationships and situations, not atomistic facts and events. Instead of explaining a whole in terms of its parts, parts began to be explained in terms of the whole.

4. The rise of systems science

Any kind of science strongly indicates a distinct branch of systematic and well-formulated knowledge and the pursuit of principles for achieving this. According to Flood and Carson (1988, p 3) this suggests that science should have a clearly recorded and coherent historical development. This is however not the case with systems science. It has a somewhat fragmented history. Some fundamental concepts now used in systems science have been present in other disciplines for many centuries, while others have emerged as recently as 40 to 50 years ago (Flood and Carson, 1988, p 2).

A good example of a concept that has been in existence for many centuries is cybernetics. The origin of the word is the Greek *kybernetes* (steersman) and *kybernetics* (Plato's art of steermanship). The contemporary meaning of the word relates to control and communication (Flood and Carson, 1988, p 3). A concept that is deeply embedded in today's systems thinking, which originated in this century, is the so-called *Gestalt*. The Gestalt movement started in Germany early in the twentieth century (Hitchins, 1992, p 6). The central tenet of Gestalt was that the whole was greater than the sum of the parts - it was thus wholistic.

The start of the twentieth century witnessed the breakdown of the mechanistic Newtonian theory (Laszlo, 1972, p 11). In physics relativity and quantum theories took over. Other sciences followed the same route. Biologists like Driesch and Bergson proposed the vitalism as a testable theory of life. These new laws that were postulated did not contradict physical laws but complemented them (Laszlo, 1972, p 12). In view of the parallel developments in physics, chemistry, biology, sociology, and economics, contemporary science became the "science of organized complexity" (Laszlo, 1972, p 12) or systems science (Flood and Carson, 1988, p 270).

The principal coming together of systems ideas occurred in the field of biology. Von Bertalanffy, the initiator of this consolidation, envisaged a framework of concepts and theory that would be equally applicable to many fields of interest. His theory, General Systems Theory (GST) is based on the idea that homologies exist between disciplines that have traditionally been considered as being separated by their different subject matters.

The pace of the systems revolution accelerated during and after World War II mainly because of the attendant problems of logistics and resource management during the war (Hitchins, 1992, p 4). Operations research and management science emerged from these studies. Systems science is thus a "young" science concerned with a different way of thinking about the world. World War II directed systems science further toward "hard" quantitative analysis. Much of the more recent work has been directed toward organization, human activity systems and the understanding/management of complexity (Hitchins, 1992, p 4), also called "soft" systems approaches.

It must be clearly stated that the emergence of Systems science does not constitute a rejection of traditional sciences, it only supplements them with a new way of thinking that is better suited to deal with complex problems (Schöderbeck *et al,* 1985, p viii).

Hitchins (1992, p 5) mentions the following people who have been influential in the shift in perception from Newtonian sciences to systems sciences. They are: [1] C. West Churchman; [2] T.S. Kuhn; [3] Karl R. Popper; [4] Sir Geoffrey Vickers; and [5] Ludwig von Bertalanffy. The key people making a contribution to the natural sciences were Ludwig von Bertalanffy and Karl Popper.

Figure A.1 from Flood and Carson (1988, p 3) illustrates the four development cycles of systems science.

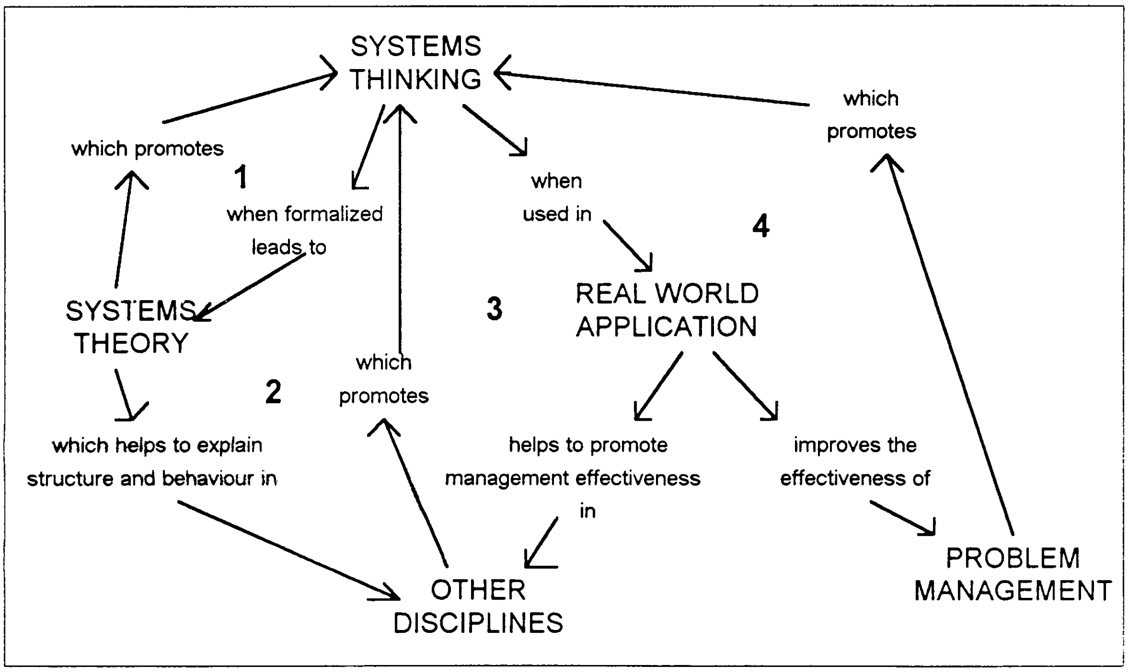

Figure A.1 : Development cycles of systems science (Flood and Carson, 1988, p 3)

A detailed summary of the many facets of systems science, which are the output of the development process described above, is given in Figure A.2 from Flood and Carson (1988, p 6). We can see how systems science has arisen from interdisciplinary studies, and how it is categorized into distinct areas.

Having established some understanding of the history of science, the reason why science shifts its sight and the rise of systems science, the deliberation now moves to a short overview on the differences between system and Newtonian science.

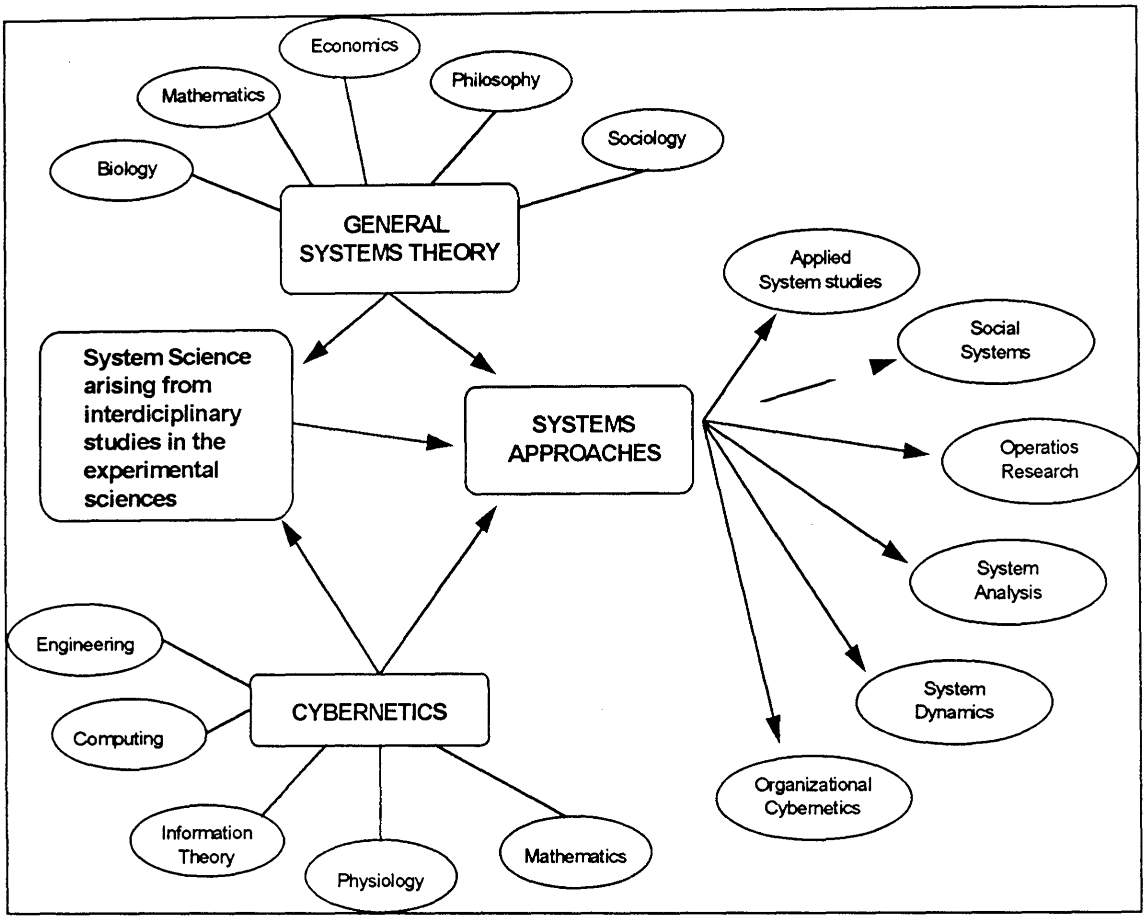

Figure A.2 : The origin and evolution of systems science (Flood and Carson, 1988, p 6)

5. Differences between systems science and Newtonian science

According to Flood and Carson (1988, p 268) there are four philosophical areas of dispute between Newtonian science and systems science, namely: ontology, epistemology, methodology and nature of man. Each of these issues are briefly discussed. In all four these areas Newtonian Science is specific and definite, while Systems Science is more open. Systems science thus incorporates both ends of the scale depending on the prevailing situation and the world-view of the thinker.

5.1. Ontology

Ontology is theory associated with what the world is or contains (Flood and Carson, 1988, p 268). The issue of debate concerns the nature of reality, being pursuit in the following opposing extremes.

5.1.1. Realism

Reality is external to the individual, it is a given and is of an objective nature. (Newtonian Science)

5.1.2. Nominalism

Reality is a product of individual consciousness, a product of one's own mind and of individual cognition.

5.2. Epistemology

Epistemology deals with the assumptions about ground knowledge. The opposing extremes are:

5.2.1. Positivism

Knowledge is hard, real and capable of being transmitted in a tangible form. (Newtonian Science)

5.2.2. Anti-positivism

Knowledge is soft, more subjective, spiritual and even transcendental. It is based on experience, insight and is essentially of a personal matter.

5.3. Methodology

Methodology is concerned with our attempts to investigate and obtain knowledge about the world. The opposing thoughts are:

5.3.1. Nomothetic

There is a search for universal laws that govern the reality that is being observed. Methodologies are based upon systematic process and technique. (Newtonian Science)

5.3.2. Ideographic

The principal concern is to understand the way an individual creates, modifies and interprets the world. An external reality is questioned. The relativistic nature of the world is emphasized, that leads to the thought that it is not amenable to study the world using the ground rules of the natural sciences.

5.4. Nature of man

Concerning the way we view the nature of man the following opposing thoughts are cited:

5.4.1. Determinism

Man is mechanistic, determined by situations in the external world. We are products of our environment and conditioned by external circumstances. (Newtonian Science)

5.4.2. Voluntarism

Man has a creative role, a free will, and he is the creator of his environment.

Moving from the philosophical to the theoretical Table A.1 from Hitchins (1992, p 13) summarizes Machine-age thinking versus System-age thinking.

MACHINE AGE **Procedure**	**SYSTEMS AGE** **Procedure**
Decompose that which is to be explained	Identify a containing system of which the thing to be explained is part
Explain behaviour or properties of the contained parts separately	Explain the behaviour or properties of the containing whole
Aggregate these explanations into an explanation of the whole (synthesis)	It explains the behaviour of the thing to be explained in terms of its role(s) and function(s) within its containing whole

Table A.1 : A comparison of machine- and systems-age thinking

To explain the table above the following example: A machine-age thinker faced with the need to explain an organization would begin by considering its departments and divisions, he would describe what each of them did and then explain how they worked together to operate as an organization. A system-age thinker would start by identifying a system containing the organization, e.g. the health care system, and would then define the functions or objectives of the health care system with reference to an even wider social system that contains it. Finally, he would explain the company in terms of its roles and functions in the health care system. According to Hitchins (1992, p 14) analysis (reduction) and synthesis both have their place. Table A.2 presents the machine-age analysis versus the system-age synthesis.

MACHINE AGE **Analysis**	**SYSTEMS AGE** **Synthesis**
Analysis focuses on structure; it reveals how things work	Synthesis focuses on function; it reveals why things operate as they do
Analysis yields knowledge	Synthesis yields understanding
Analysis enables description	Synthesis enables explanation
Analysis looks into things	Synthesis looks out of things

Table A.2 : A comparison of machine-age analysis and systems-age synthesis

The systems view always treats systems as integrated wholes of their subsidiary components and never as the mechanistic aggregate of parts in isolable causal relations (Laszlo, 1972, p 15). The systems view is the view of organized complexity, one step beyond the Newtonian view of organized simplicity.

According to Hitchins (1992, p 4) the systems discipline is a meta-discipline, sitting "above" conventional disciplines, seeking to provide an umbrella over them, and to establish a comprehensive and universal set of principles.

To enlighten the evolution of systems science, General Systems Theory, "hard" and "soft" systems are briefly discussed.

6. General systems theory (GST), "Hard" and "Soft" sciences

The General Systems Theory was developed by Ludwig von Bertalanffy in the early 1950s. It however has not fulfilled its promise of a single approach to all systems (Hitchins, 1992, p 47). The social, behavioural and management sciences are still essentially separated from the traditional, "harder" sciences such as physics and chemistry. The social and management sciences ("soft" sciences), however, made advances in methods without mathematical rigour seen as fundamental by the physical sciences (Hitchins, 1992, p 46).

The "soft" sciences have gained some success in their approach to the delicate subject of complex issues. They use so-called soft methods, organization development interventions and so on (Hitchins, 1992, p 48). They seek to understand complex situations and perhaps to improve situations, rather than to proffer optimal solutions - which is the goal of hard systems practitioners. Soft methods are often procedural, frequently interactive, encouraging commitment through participation, developing consensus rather than solving problems.

There are a variety of "soft" systems approaches. Some are of considerable interest, particularly in the field of management, e.g., Soft Systems Methodology of Peter Checkland and decision based approaches.

After the foregoing introduction on systems science it is appropriate to look into the definition of systems.

7. Definition of systems

Authors define systems differently. The following are a few possibilities:

- ⇨ Complex whole, set of connected things or parts; organized body of material or immaterial things.
- ⇨ Group of bodies moving about one another in space under some dynamic law.
- ⇨ Orderly arrangement or method.
- ⇨ A system is a whole that cannot be taken apart without loss of its essential characteristics (Schöderbeck *et al*, 1985, p vii).
- ⇨ A group of elements, either human or non human, that is organized and arranged in such a way that the elements can act as a whole toward achieving some common goal, objective, or end (Kerzner, 1992, p 77).

These definitions sound a bit all-embracing, but according to Hitchins (1992, p 3) "systems" is such a broad concept that it might seem impossible to find common ground between various definitions.

All these definitions give rise to a variety of viewpoints, or *Weltanschauungen* (world views) (Hitchins, 1992, p 4). If we can look at a system from different viewpoints, we can perhaps see different features and gain better understanding. The development of different viewpoints when exploring a problem situation is a keystone of modern systems thinking.

For the purpose of this study a system is defined as: An assembly of elements related in an organized whole (Flood and Carson, 1988, p 7). A few essential system characteristics are discussed.

8. System characteristics

Schoderbeck *et al* (1990, p 9) outlines five basic considerations concerning systems thinking:

1. **Objectives of the total system together with performance measures**

   By objectives of the system is meant those goals or ends toward which the system tends.

2. **The system's environment**

   The environment constitutes all that is outside the system.

3. **The resources of the system**

   Resources are all the means available to the system for the execution of the activities necessary for goal realization.

4. **The components of the system**

   The components include the mission, jobs or activities the system must perform to realize its objectives.

5. **The management of the system**

   Two basic functions are included, namely planning the system and controlling the system.

As scientists (Newtonian or System) we always try to classify phenomena. It is not different within the systems science, therefore it is appropriate to discuss some classifications found within the field.

9. Classification

There seems to be two fundamental ways of thinking: the hard/soft and the open/closed. Hard systems are described as follows (Hitchins, 1992, p 7):
A certain objective is given; to find ways and means for its realization requires the system specialist (or team of specialists) to consider alternative solutions and to choose those offering optimization at maximum efficiency and minimum cost in a tremendously complex network of interactions.

The soft systems viewpoint (mostly held by behavioural, management and other social sciences) is described by Hitchins (1992, p 7) as follows: Hard systems thinkers view systems like bags of marbles; you can put your hand in the bag, remove a marble, examine it, replace it and all is well. Soft systems thinkers view systems like a privet hedge; if you try to pull out a branch, you will strip off its leaves and twigs, damage the hedge in the process, and it is not replaceable.

Boulding (1956, p 201) developed a system classification as shown in Table A.3.

LEVEL	CHARACTERISTICS	EXAMPLE
1. Structures	Static	Bridges
2. Clockworks	Predetermined motion	Solar system
3. Controls	Closed loop control	Thermostat
4. Open	Self-maintaining	Biological cells
5. Lower organisms	Growth, reproduction	Plants
6. Animals	Brain, learning	Birds
7. Man	Knowledge, symbolism	Humans
8. Social	Communication, value	Organizations, families
9. Transcendental	Unknowables	God

Table A.3 : Boulding's systems classification

According to Hitchins (1992, p 8) the first three levels can be classified as physical or mechanical systems (hard systems), and they are the province of the physical sciences. The fourth to sixth levels are concerned with biological systems and are the province of biologists, botanists and zoologists. The last three levels are the concern of the social sciences and of arts, humanities and religion. As the hierarchy is ascended the systems seem to become progressively "softer".

Classifying systems as open or closed is a common phenomenon. Boulding (1956, p 202) suggests that the first three levels present closed systems, while the rest are open. Hitchins (1992, p 9) states that it would seem to be prudent to start by assuming all systems-to-be-understood are open until proven otherwise.

Hitchins (1992, p 9) states that systems may also be considered in principle by: rate of change, purpose or connectivity. These different perspectives are shown in Figure A.3.

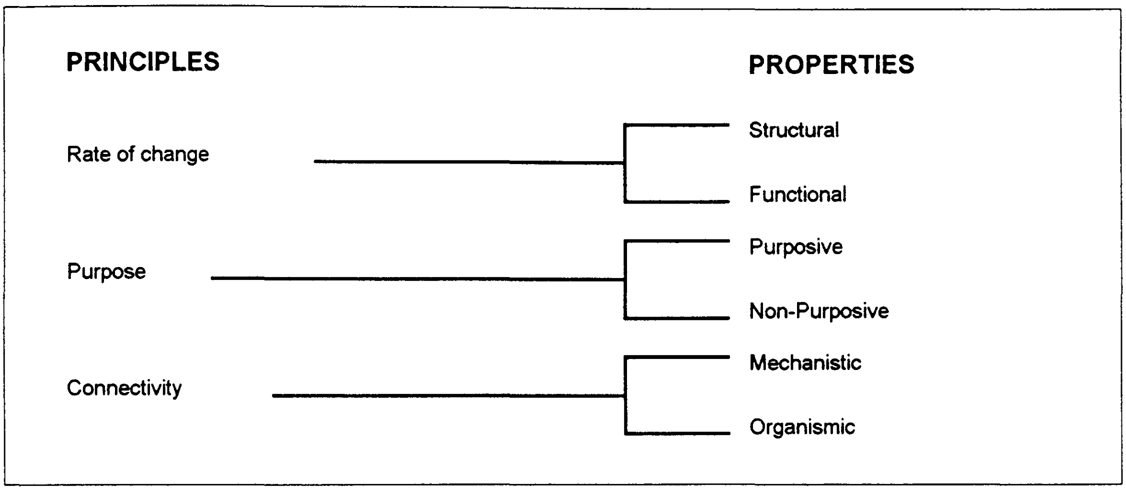

Figure A.3 : Hitchins systems classification

10. Fundamental system concepts

Schoderbeck *et al* (1990, p 13) and Hitchins (1992, p10) identifies the following concepts as fundamental to systems:

- Set
- Objects
- Relationships
- Attributes
- Environment
- Whole
- Complexity
- Emergence
- Hierarchy

10.1. Set

A set means any well-defined collection of elements or objects within some frame of discourse.

10.2. Objects

Objects are elements of a system. There are three kinds of objects: inputs, processes and outputs.

10.3. Relationships

Relationships are the bonds that link the objects together.

10.4. Attributes

Attributes are properties of both objects and relationships

10.5. Environment

The environment is that which is outside the system. The environment determines in some way the performance of the system. Because the environment lies outside the system there is little if anything the system can do to control its behaviour.

10.6. Whole

The whole is an independent framework in which the parts play a distinctive role. The synergistic principle that the whole is greater than the sum of its parts implies that the whole does not only exist of the different parts, but also of the relationship between the parts.

10.7. Complexity

According to Schöderbeck *et al* (1985, p 5) the complexity of a system is determined by the number of elements in the system, their attributes, the interactions between them, and the degree of organization inherent in the system.

10.8. Emergence

According to Hitchins (1992, p 10) emergence or emergent properties implies the principle that whole entities exhibit properties which are meaningful only when attributed to the whole, not to its parts. Every system thus exhibits emergent properties which derive from its component activities and structure, but cannot be reduced to them. This concept is fundamental to systems thinking, analysis and synthesis.

10.9. Hierarchy

Hitchins (1992, p 11) defines hierarchy as the principle according to which entities meaningfully treated as wholes are built up of smaller entities which themselves are wholes and so on. In a hierarchy, emergent properties denote levels.

The definition of systems, some system characteristics, system classification and some fundamental system concepts have been deliberated. It makes sense to now discuss the application of systems science to management.

11. Systems science applied to management

The General Systems Theory of Boulding and von Bertalanffy was translated into a meaningful organization and management theory in the early sixties. Johnson *et al,* (1967, p 132) made the following statement:

> *"An organism is an open system which maintains a constant state while matter and energy which enter it keep changing. The organism is influenced by, and influences its environment. Such a description of a system adequately fits the typical business organization. The business organization is a manmade system which has a dynamic interplay with its environment - customers, competitors, labor organizations, suppliers, government and many other agencies. Furthermore, the business organization is a system of interrelated parts working in conjunction with each other in order to accomplish a number of goals, both those of the organization and those of the individual participants."*

The authors continue to relate an organization to the second level of Boulding's classification, namely that of clockwork systems. The application of system theory to business implies a management technique that is able to cut across many organizational disciplines, while still carrying out the function of management. This technique has come to be called systems management, project management, or matrix management (Kerzner, 1992, p 72).

In order to explore the subject of systems science applied to management, attention is given to project management, cybernetics, decision making, problem solving and evaluation.

11.1. Project management

According to Kerzner (1992, p 79) a project should be seen as a sub-system relating to siblings and the parent system (organization) in a purely systems way. We can thus apply the total management systems theory to the management of a project.

Kerzner (1992, p 4) defines a project as any series of activities or tasks that:

- ⇨ Have a specific objective to be completed within certain specifications
- ⇨ Have defined start and end dates
- ⇨ Have funding limits
- ⇨ Consume resources

The same author continues to define project management as:
"...the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals or objectives. Furthermore, project management utilizes the systems approach to management by having personnel (the vertical hierarchy) assigned to a specific project (the horizontal hierarchy)."

Kerzner (1992, p 79) categorizes projects in four main groups, namely:

1. **Individual projects.** These are short duration projects normally assigned to a single individual who may be acting as both a project manager and a functional manager.

2. **Staff projects.** These are projects that can be accomplished by one organizational unit, say a department. A staff or task force is developed from each section involved. This works best if only one functional unit is involved.

3. **Special projects.** Very often special projects occur that require certain primary functions and/or authority to be assigned temporarily to other individuals or units. This works best for short duration projects. Long-term projects can lead to severe conflicts under this arrangement.

4. **Matrix or aggregate projects.** These require inputs from a large number of functional units and usually control vast resources.

In order to manage a project according to the management systems theory the project manager must (Kerzner, 1992, p 80):

- ⇨ Set objectives
- ⇨ Establish plans
- ⇨ Organize resources
- ⇨ Staff
- ⇨ Set up controls

- Issue directives
- Motivate personnel
- Apply innovation for alternative actions
- Remain flexible
- Communicate well on different organizational levels

The success of a project is defined by Kerzner (1992, p 6) as the completion of a project:

- within the allocated time period
- within the budgeted cost
- at the proper performance or specification level
- with acceptance by the customer
- with minimum or mutually agreed upon scope changes
- without disturbing the main work flow of the organization
- without changing corporate culture

11.2. Cybernetics

Hitchins (1992, p 11) stated the following definitions for cybernetics:

- The science of effective communication in man and machine.
- The science of effective organizations.

Figure A.4 from Hitchins (1992, p 11) presents the cybernetic model. The Control Unit compares actual output with desired output; the Activating Unit receives signals from the Control Unit and responds by making changes in the Controlled Process; the Controlled Process is that which is being controlled; and the Information System measures actual output and relays information to the Control Unit.

The characteristics associated with cybernetic systems include (Hitchins, 1992, p 11) :

- Complex
- Dynamic
- Probabilistic
- Integrated
- Open

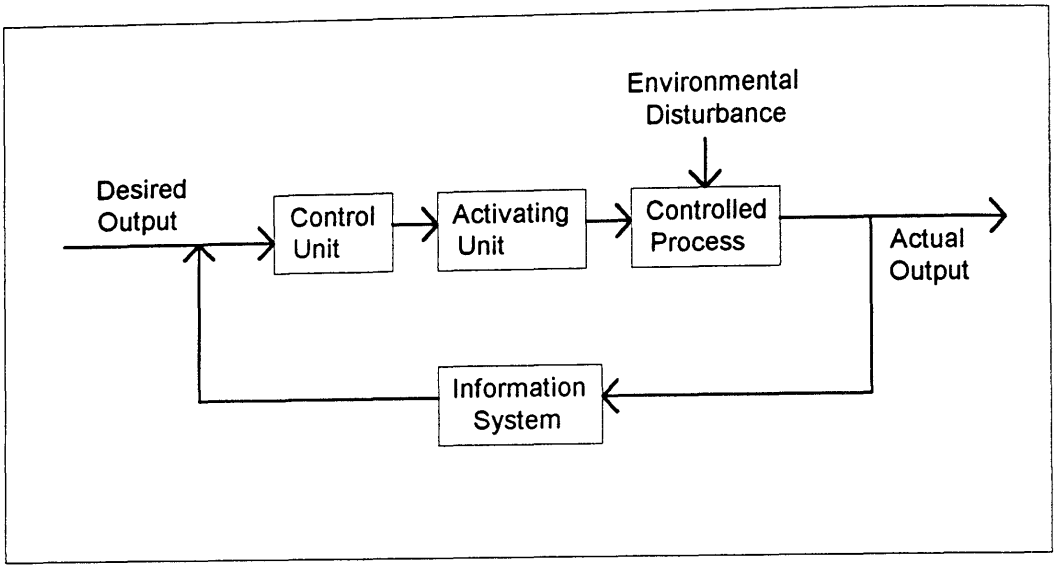

Figure A.4 : A cybernetic model

Hitchins (1992, p 12) proposes some important cybernetic principles as follows:

- ⇨ Complex systems organize themselves
- ⇨ Complex systems have basins of stability separated by thresholds of instability
- ⇨ Outputs that are important to a system will have feedback loops

11.3. Making decisions

In a dynamic situation change is the order of the day. With many factors changing in an unpredictable situation, it may be impossible to determine the correctness of a decision, since cause and effect may be impossible to unravel (Hitchins, 1992, p 33). Due to the preceding reasoning Hitchins (1992, p 35) proposes the following decision making process (Figure A.5).

Another approach to decision making is that of Friend. According to Hitchins (1992, p 21) Friend states that complexity is not systemic, so it is better approached from a decision perspective than from a systems perspective. Friend draws together concepts, approaches and methods from operations research and from the social sciences into a framework which operates in one of four modes. His ideas show an orderly progression towards a decision. This method has been applied with success in community health services (Hitchins, 1992, p. 21). Figure A.6 illustrates the approach to handling complex environments.

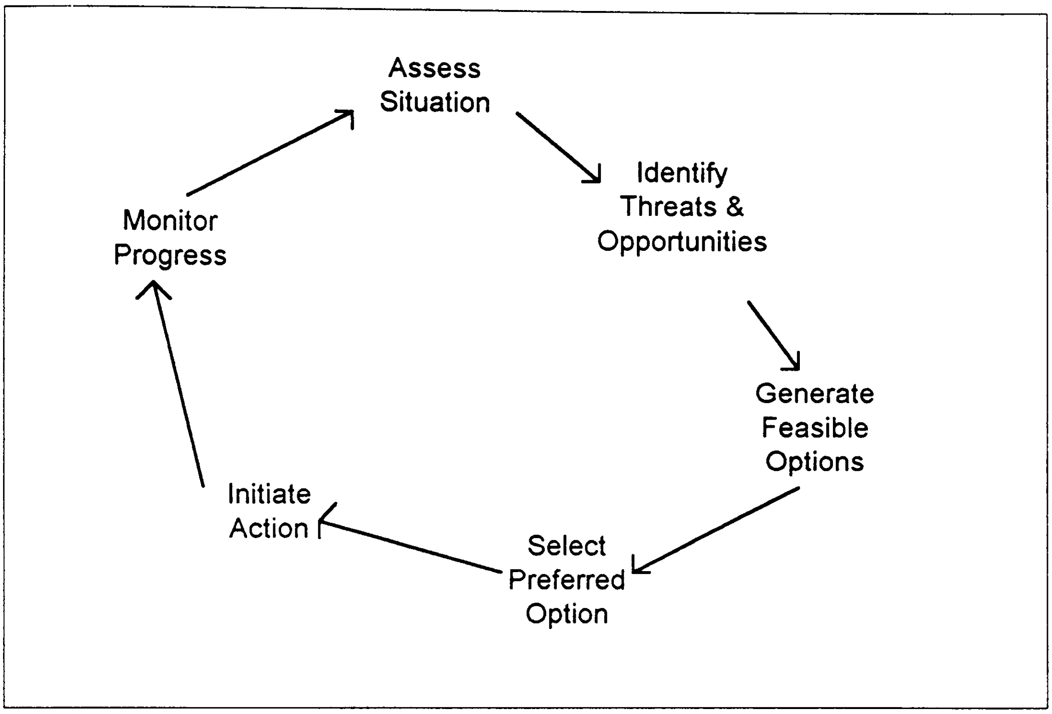

Figure A.5 : The decision circle (Hitchins, 1992, p 35)

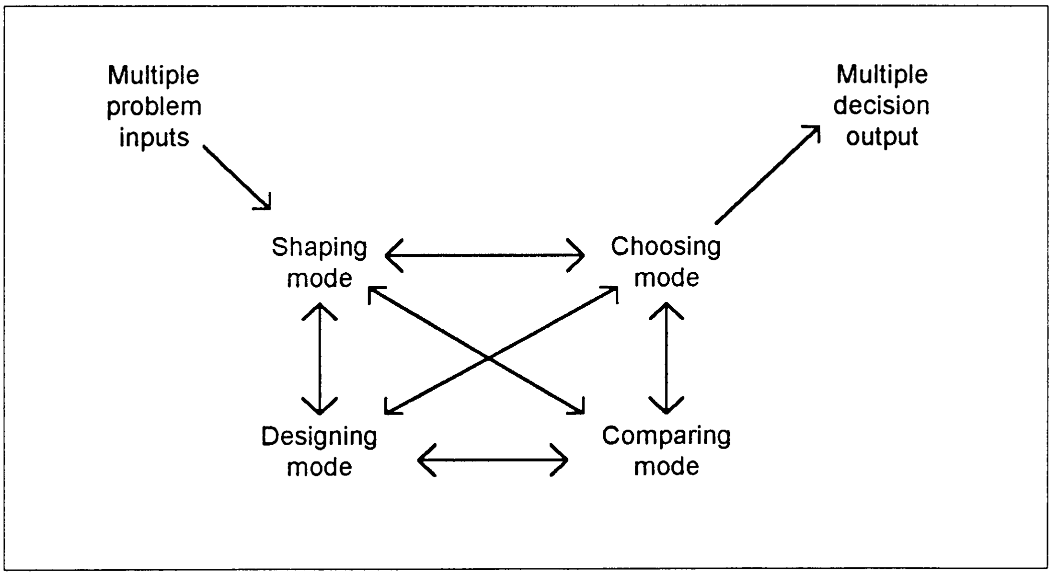

Figure A.6 : Decision-based approach to handling complex environments (Hitchins, 1992, p 22)

11.4. Problem solving

The systems approach to problem solving focuses on the system taken as a whole, not on the parts taken separately (Ackoff, 1971, p 661). Such an approach is concerned with total-system performance even when a change in only one or a few of its parts is contemplated because there are some properties of systems that can only be treated adequately from a wholistic point of view.

Different methods of inquiry that man has developed in order to deal with problems are briefly discussed. To understand the development of the discussed techniques we need to clarify the understanding of the concept *problem*. There are two different ways to define a problem, namely the hard systems view and the soft systems view. According to the hard systems view a *problem* is a "doubtful or difficult matter requiring solution; something hard to understand or accomplish or deal with" (Flood and Carson, 1988, p 106). The soft systems view defines a *problem* as one which arises in the everyday world of events and ideas, and may be perceived differently by different people. These problems are not constructed by the investigator as are laboratory problems (Flood and Carson, 1988, p 106).

From these foregoing two definitions it follows that there will be two divided methodologies to problem solving. These systems methodologies have evolved alongside philosophies. At times these methodologies point to the need for techniques. To clarify the meaning of the words philosophy, methodology and technique the following operational definitions from Flood and Carson (1988, p 106):

Philosophy: A broad non-specific guideline for action.

Technique: A precise specific program of action that will produce a standard result.

Methodology: It lacks the precision of a technique, but will be a firmer guide to action than a philosophy.

11.4.1. Hard systems methodologies

According to Flood and Carson (1988, p 107) hard systems methodologies set out to select an efficient means of achieving a known and defined end. The same authors considered the following to be hard systems methodologies: Systems analysis; Systems engineering; and Operations research.

11.4.1.1. Systems analysis

According to Flood and Carson (1988, p 108), Checkland defines systems analysis as the systematic appraisal of the costs and other implications of meeting a defined requirement in various ways.

Flood and Carson (1988, p 108) describe systems analysis as a four step sequence (Fig A.7), namely problem analysis, generation of alternative solutions, evaluations of the alternatives and the selection of the optimal alternative.

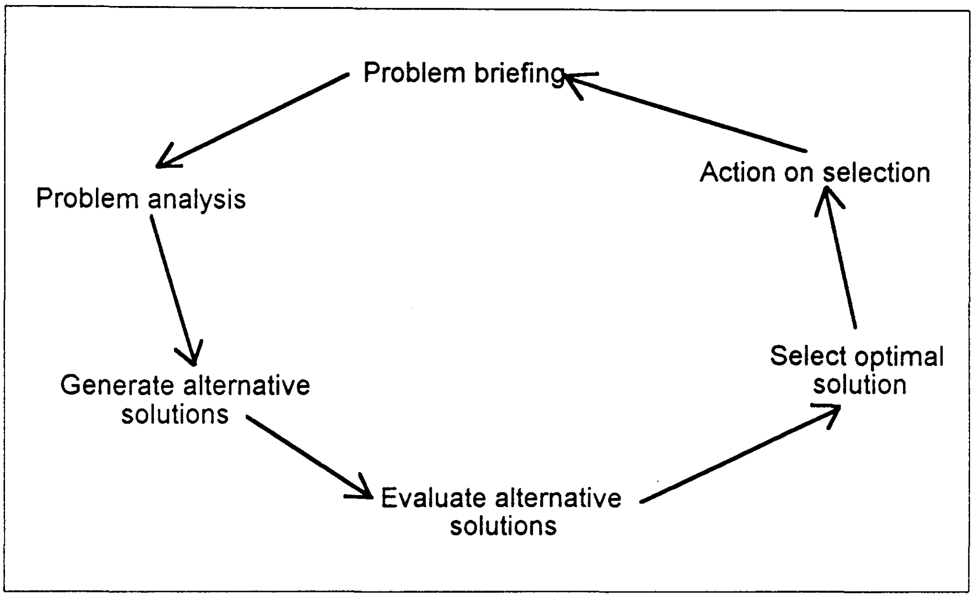

Figure A.7 : Systems analysis problem solving loop (Flood and Carson, 1988, p 109)

11.4.1.2. Systems engineering

This methodology also passes through four stages (Figure A.8), namely systems analysis, systems design, implementation and operation (Flood and Carson, 1988, p 110).

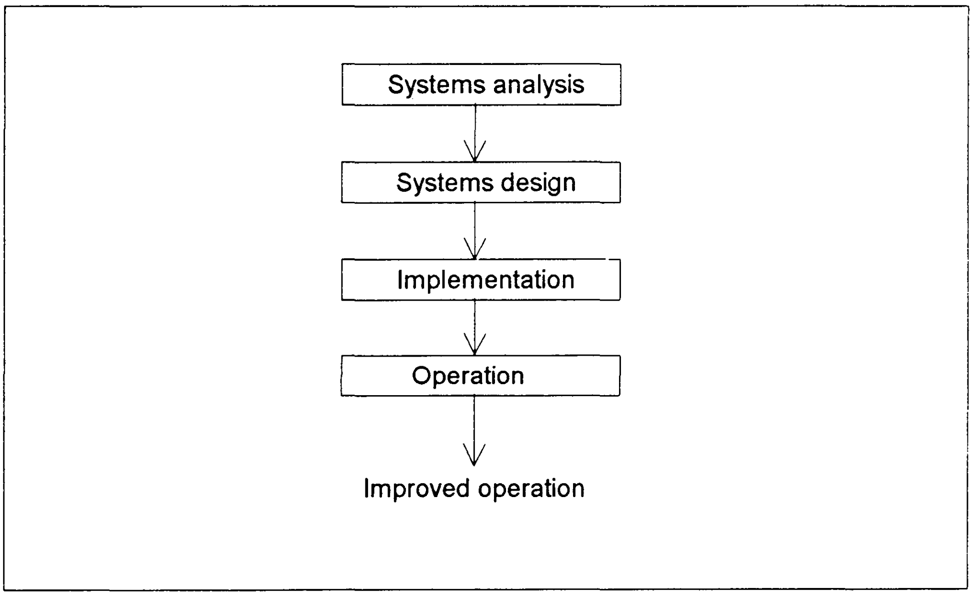

Figure A.8 : Systems engineering methodology (Flood and Carson, 1988, p 110)

11.4.1.3. Operations research

Flood and Carson (1988, p 113) described operations research as a five stage process, namely formulation of the problem, constructing a mathematical model, deriving a solution to the model, testing the model and evaluating the solution, and implementing and maintaining the solution.

Flood and Carson (1988, p 116) stated that the three preceding hard system methodologies are being used in both operations-in-being and operations-in-prospect. The thoughts of Peter Checkland, that there are "soft problems" that cannot be formulated as a search for an efficient means of achieving a defined end (Flood and Carson, 1988, p 107), contributes to the development of soft systems thinking. It was thus the perceived inappropriateness of means-end, objective-seeking approaches in problematic situations, that gave rise to the methodology of soft systems.

11.4.2. Soft systems methodology (SSM)

According to Hitchins (1992, p 18) Checkland's Soft Systems Methodology conceives of hierarchies of systems. A classical simple route in exploring problems is followed. In essence he appreciates a real life problem, develops a variety of viewpoints concerning the real problem situation, forms idealized conceptual models of the problem situation, compares characteristic features of the idealized model with the real world, and then identifies any feasible and desirable change. By choosing a variety of viewpoints he hopes to bring robustness to the process and avoid the pitfalls of pre-conceptions. Figure A.9 demonstrates Checkland's Soft Systems Methodology.

The soft systems methodology is described by Checkland as a logical 1 to 7 sequence that is most suitable for describing it, but which does not have to be followed in using it! Backtracking and iteration are also essential; in fact the most effective users of the methodology have been able to use it as a framework into which to place purposeful activity during a systems study, rather than a recipe in a cookery book. In an actual study the most effective systems thinker will be working simultaneously, at different levels of detail, on several stages (Flood and Carson, 1988, 117). Flood and Carson (1988, p 117-124) described the stages in SSM as follows.

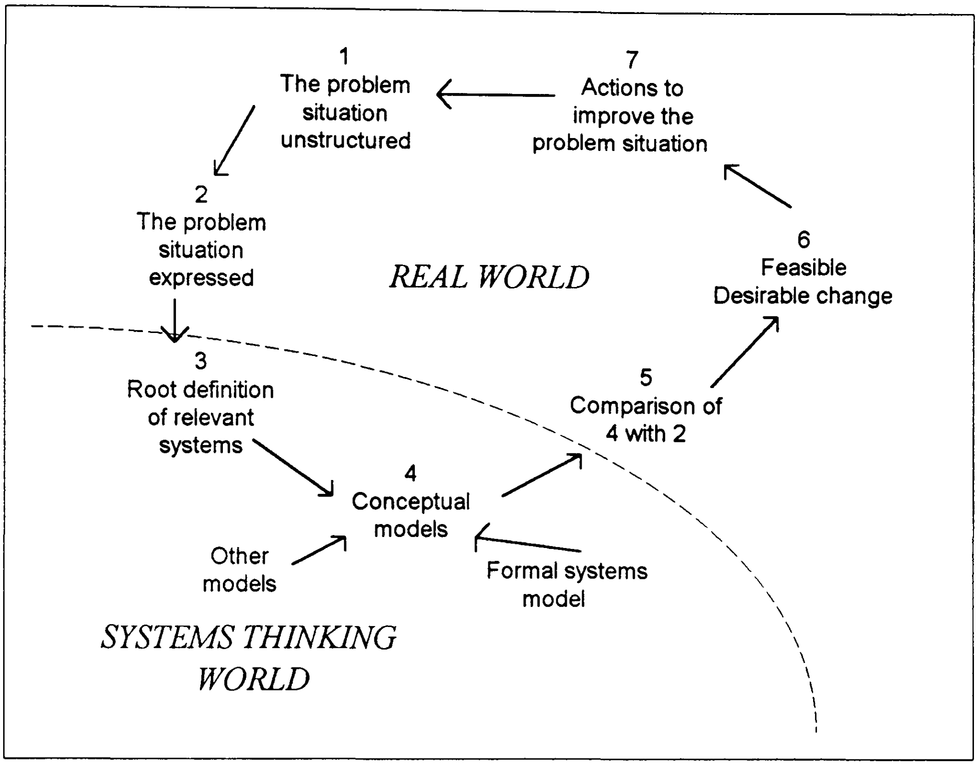

Figure A.9 : Soft Systems Methodology (Flood and Carson, 1988, p 119)

11.4.2.1. Stages 1 and 2

The aim is to achieve an objective representation of the problematic situation. To achieve this a **rich picture** is built, which contributes to the following development of a set of viewpoints, each offering a distinct angle from which the problematic situation may be investigated. The function of stages 1 and 2 is to display the situation so that a range of possib' and, hopefully, relevant choices can be revealed. Examining the structure, the process and their interrelationship (climate) is emphasized.

11.4.2.2. Stages 3 and 4

To achieve the development of a more explicit account of the names of the notional systems which seem relevant to the problematic situation a root definition is developed. The main function of the root definition is to assert that, in the view of the analyst, taking this to be a relevant system, making a conceptual model of the system, and comparing it with present realities is likely to lead to illumination of the problems and hence the solution.

Firstly all the relevant systems are identified, a root definition for every system is written down, a CATWOE analysis is done on each relevant system and finally a conceptual model is constructed.

The use of the CATWOE analysis is that the root definition of a relevant system should reflect the aspects of CATWOE:

C: Customer - who would be victims or the beneficiaries of this system?

A: Actor - Who would perform the activities?

T: Transformation - What input is transformed into what output?

W: Weltanschauung - What view of the world makes this system meaningful?

O: Owner - Who could abolish the system?

E: Environmental constraints - What in the environment does the system take as given?

11.4.2.3. Stage 5

After the learning process has progressed to a point where at least one of the perceptions taken gives a strong indication that some real insight in the problematic situation has been gained, then comparison of the conceptual model with reality may properly be tackled. Table A.4 is an example of how to compare reality with the conceptual model.

Activity in conceptual model	Present in real-world situation?	Comments	Include on agenda

Table A.4 : Table to compare reality and conceptual model (Flood and Carson, 1988, p 124)

11.4.2.4. Stages 6 and 7

Feasible and systemically desirable changes to structure, process, or attitude may emerge from the foregoing discussion. The desirable change is then implemented and evaluated to see whether the actions lead to some useful outcome or not.

The elements of the formal systems model require that a system has the following characteristics (Hitchins, 1992, p: 19):

- ⇨ Purpose or mission
- ⇨ Measurable performance
- ⇨ A decision-making process
- ⇨ Components which are themselves systems
- ⇨ Components which mutually interact
- ⇨ A boundary
- ⇨ Resources
- ⇨ Continuity
- ⇨ Exists in a wider system and/or environment with which it interacts

11.5. Evaluation

We are continually seeking to improve our systems, to make them better. We need yardsticks, measures by which to judge whether our actions will produce, or have produced, the expected results. The common evaluation criteria: efficiency, effectiveness, cost-effectiveness and net contribution are discussed from a systems viewpoint.

11.5.1. Efficiency

According to Hitchins (1992, p 87) Figure A.9 shows the basis of efficiency.

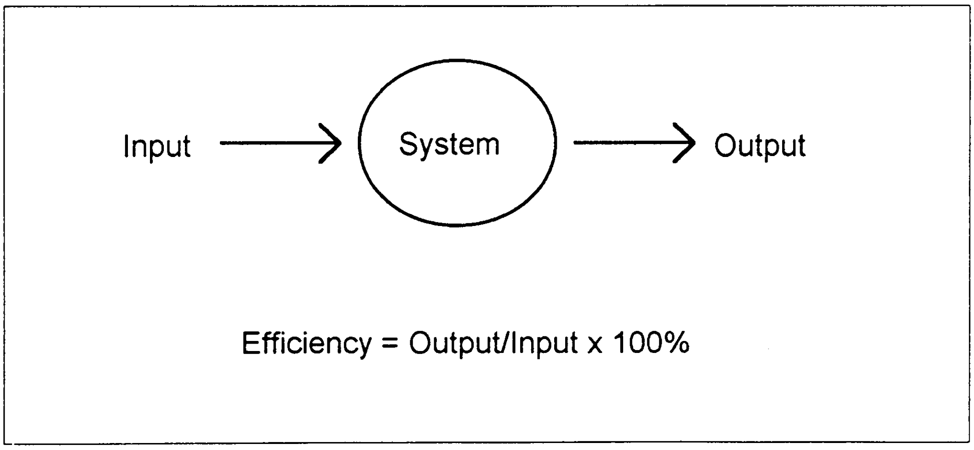

Figure A.9 : System efficiency (Hitchins, 1992, p 87)

The value of efficiency seems to be that it indicates how much of the input is wasted because it never appears at the output. Assessing the efficiency of organizations or projects, the overall cost of running or implementation may be seen as the input, while the output may be measured as the result or product being produced. Accepting this formula and looking at nature some management experts might declare Nature to be so inefficient that it should be replaced (Hitchins, 1992, p 88). But Nature has a different goal - survival. In most systems, there is a host of sub-systems performing a variety of jobs; power is dissipated at each transition between sub-systems or processes. This might explain Nature's seemingly low efficiencies and it also indicates the robustness of natural systems. They contain variety and capacity sufficient to accommodate change and to resist threats. High efficiency systems forego this robustness and do not survive for long (Hitchins, 1992, p 88).

Although survival is not the only business goal, an organization that survives is winning in some way. Using survival as a goal does not mean that an organization should not be efficient, but it does put efficiency in perspective (Hitchins, 1992, p 89).

According to the systems view no system is isolated. They are all mutually connected and contained within wider systems. Figure A.10 indicates that the output from one system must form the input to one or more other systems (Hitchins, 1992, p 89). The system itself receives its input from one or more systems upstream. Altering the efficiency of the system will affect the input and/or output which will again affect other systems.

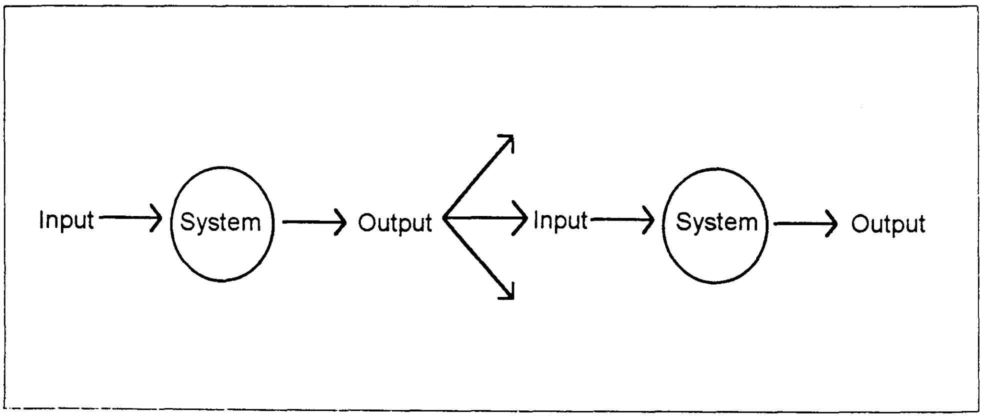

Figure A.10 : System changes - downstream impact (Hitchins, 1992, p 91)

Hitchins (1992, p 89) presents the following view of efficiency as a systems evaluation criterion.

- ⇨ Efficiency = Output/Input
- ⇨ Introspective
- ⇨ Ignores Value/Impact of Output

- ⇨ Ignores Value/Cost of Input
- ⇨ Output from the first system is the Input to the following systems
- ⇨ Changing efficiency of first system disturbs all subsequent systems
- ⇨ Net result needs to be beneficial

The evaluation of systems efficiency is not the unassailable ethic that might be supposed. This does not mean that efficiency is of no value. It is a valuable tool in the armoury to improve systems performance when it is used in conjunction with other measures (Hitchins, 1992, p 92). Hitchins (1992, p 92) suggests that efficiency should be used to choose between different strategies.

11.5.2. Effectiveness

Effectiveness offers an external view of a system. It assesses the system's emergent properties (Hitchins, 1992, p 92). Effectiveness is to do the right thing. Defining this "right thing" is often very difficult or impossible.

According to Hitchins (1992, p 92) the process of evaluating effectiveness (when the "right thing" cannot be measured) can be seen as comprising two parts:

- ⇨ Establish an ideal model of the system in its environment, interacting with other systems in that environment.
- ⇨ Compare the proposed or existing system against the model to identify and highlight differences.

The difference between the ideal and the actual can be used to measure effectiveness and/or promote change. The assessment of effectiveness seems to be made the best under three headings:

- ⇨ Contribution to containing systems' objectives
- ⇨ Co-operation with sibling systems
- ⇨ Harmony of contained systems

According to Hitchins (1992, p 94) effectiveness can be measured in practice by evaluating the following emergent properties:

- ⇨ Performance
- ⇨ Availability
- ⇨ Adaptability
- ⇨ Interoperability
- ⇨ Usability
- ⇨ Survivability
- ⇨ Security
- ⇨ Safety

Effectiveness is thus a potential valuable measure because it could assess the degree to which a system or process serves its purpose and harmonizes with other systems in the environment. The measurement is, however, not a simple process. It requires the establishment of standards which emergent properties should satisfy (Hitchins, 1992, p 95).

11.5.3. Cost-effectiveness

Cost-effectiveness reflects, according to Hitchins (1992, p 95), a natural interest in cost as being of prime importance, and of money as being the universal exchange for goods, services, etc., which we use *inter alia* to choose between options. Cost-effectiveness seeks to maximize "value for money" by maximizing the ratio of effectiveness to cost. According to Hitchins (1992, p 95) this is an important idea since it allows more expensive options to be accepted if they offer proportionately more effectiveness.

In a system cost-effectiveness can be seen as "valued emergent properties per cost", where valued emergent properties are those which serve higher purpose and harmonize with those of other systems.

The usual approach to the assessment of cost-effectiveness is illustrated in the Figure A.11 from Hitchins (1992, p 96).

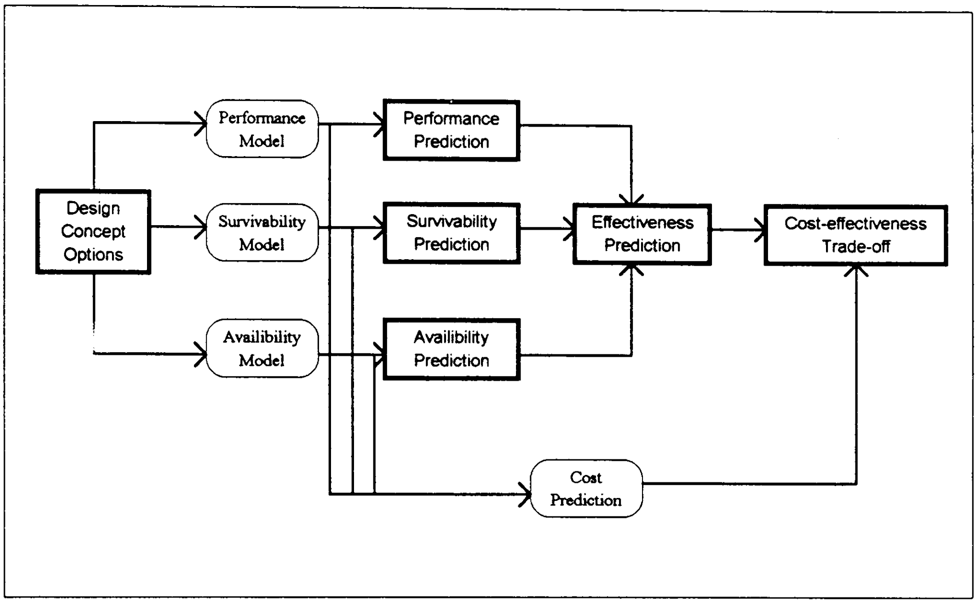

Figure A.11 : Cost-effectiveness model (Hitchins, 1992, p 30)

A variety of potential solutions are generated. Each is processed against a set of models to predict performance, availability and survivability to determine overall effectiveness and cost, these two being ratioed for each option, the highest value giving the preferred solution.

Hitchins (1992, p 97) proposes cost-effectiveness as a useful measure for system evaluation. The fact that it addresses both emergent properties and cost is admirable. Hitchins (1992, p 97), however, warns against the misuse of the technique. Organizations choosing options which are cost-effective from their perspective, can aggregate to provide overall-unpleasant emergent properties. The satisfaction of the clients or patients should not be neglected. Cost-effectiveness can also be misapplied by choosing an item as part of a larger system so that, while the item may be cost-effective by comparison with similar competitors, its effect on the larger system is counter-productive (Hitchins, 1992, p 98).

11.5.4. Net contribution

The Net Contribution assessment process starts from a higher level in the hierarchy of systems than does either efficiency or effectiveness (Hitchins, 1992, p 98). Hitchins (1992, p 98) states that in order to evaluate any system, a model of the system-in-focus is required, operating with other (sibling) systems within its environment. The parent or containing system should be identified as well as the sibling systems contained within it. The sibling systems' attributes should be apportioned so that the containing system's requisite features are realized. The process can be seen as budgeting, illustrated in Figure A.12 from Hitchins (1992, p 99).

SIBLING'S EMERGENT PROPERTIES	CONTAINED SYSTEMS									
POSITIVE CONTRIBUTIONS	A	B	C	D	E	SIF	N	X	Y	Z
e.g. Performance										
Availability										
NEGATIVE CONTRIBUTIONS										
e.g. Cost										
Community acceptance										
	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩

IDEAL EMERGENT PROPERTIES FOR EACH CONTAINED SYSTEM

Figure A.12 : Sibling contribution budget (Hitchins, 1992, p 99)

Figure A.12 shows a matrix in which the columns at the right represent each of the sibling systems in the containing system. The left hand column contains a set of emergent properties for the system-in-focus (SIF). In the example the overall weight of the containing system is required to be 30 units. The budget apportions these 30 units between each of the contained systems, such that the system-in-focus is ideally weighing 5 units.

The outcome of the budgeting process is an idealized set of emergent properties for the system-in-focus. The evaluation process then follows the following two steps:

- ⇨ Evaluate the optional solutions for the system-in-focus against the idealized emergent properties.
- ⇨ Where shortfalls occur seek to re-budget by trading with other contained systems.

If no compensation between the contained systems can be achieved then the option must be rejected. A system-in-focus is selected which must be both in harmony with its siblings and making the required Net Contribution to the containing system.

The feature of interconnected systems, namely downstream system flow, must be accommodated within the Net Contribution process. If the system-in-focus provides a different output to the "downstream" system then either:

- ⇨ The downstream system may be modified to accommodate the difference, or
- ⇨ A complementary system may be introduced to compensate.

After the budgeting process is completed a table is set up which evaluate possible options against the ideal situation. In conclusion, Hitchins states that Net Contribution provides an absolute measure, by asking the question "how do the emergent properties of the system-in-focus contribute to its containing system?".

The discussion finally gives attention to some thoughts on oral health care systems.

12. Oral health care systems

In 1970 the WHO embarked on a study to develop a methodology for the assessment and enhancement of oral health delivery systems (WHO, 1985, p xiii). The study focused on the effect which the oral health care delivery systems had on the oral health status of the population.

The search for one or more systems or combinations of system features which could be recommended has resulted in only tentative ideas about effective and/or inefficient components that might be drawn from existing systems. One of the main findings of the study was the lack of essential associations between any existing treatment system and effective preventive programmes (WHO, 1985, p 217).

The WHO (1985, p 217) indicates that nothing in their study suggests that a particular system or combination of system features is the answer to better oral health. The main impression, however, is that there is an urgent need to define a delivery system which is relevant to and adequate for the changing needs of the community it services. Reducing oral disease risk through appropriate prevention and meeting residual treatment needs through services remains the essential goal. The author suggest that a different philosophy stressing health and not oral disease is needed. Some of the specific features of such an approach might be a more balanced distribution of prevention and treatment services, surveillance of trends and examinations of prevailing systems and manpower productivity. Fundamental to these changes is the concept of primary health care, which must form the base of the oral health system.

13. Summary

The deliberation started with a description of the history of science, it then proposed a reason why science shifted its sight, whereafter the rise of systems science was described. The differences between Systems science and Newtonian science were briefly discussed, and then the deliberation moved to General System Theory, hard and soft sciences, and a definition and description of systems. A classification of systems and some fundamental system concepts were discussed, whereafter the deliberation moved to the application of systems science to management. A short discussion on oral health care systems was finally presented. It is concluded that systems science may answer some of the problematic real life questions, even those relating to oral health.

APPENDIX B

REVIEW ON THE RELEVANT RESEARCH LITERATURE ON PIT AND FISSURE SEALANTS

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APPENDIX B

REVIEW ON THE RELEVANT RESEARCH LITERATURE ON PIT AND FISSURE SEALANTS

1. Introduction

Pit and fissure sealants have been introduced to dental science almost 30 years ago. Many questions have been asked and many have been answered. The questions not answered are mainly in the economic domain. This overview on the literature is presented to provide a basis for the implementation and evaluation of the fissure sealant project in the Oral Health Service of the SAMS.

The overview starts with a short discussion on the theoretical approaches to prevention and the history of the prevention of pit and fissure caries. The world-wide caries status and tendencies are then discussed posing the question whether fissure sealants are still relevant. This question is then clarified from an analysis of epidemiological data. The discussion then moves to the different uses of fissure sealants, the indications for their use, the technique, time, manpower and materials required for placement, a brief comparison between sealants and amalgams, and the evaluation (efficacy, effectiveness and efficiency) of fissure sealants. Finally a brief summary of the subject from the view of the author is presented.

2. Theoretical approaches to prevention

Dental caries is a multi-factoral disease (Elderton, 1990, p 147). Elderton (1990, p 146) emphasizes the fact that while a susceptible tooth, bacterial plaque and dietary sugar are generally present in most mouths, the outcome of their interaction is dependent upon a time factor. This relationship is explained in Figure B.1 (Elderton, 1990, p 144).

If all these factors are essential for the development of dental caries, the disease can be prevented by eliminating or strengthening at least one of the factors. Several approaches to prevention developed from this theory, namely: (1) controlling the diet; (2) plaque control; (3) Chlorhexidine; (4) fluoride regimens; (5) vaccination; (6) fissure sealants (Elderton, 1991, p 146-162); and lasers (Kaufman, 1988, p 548).

APPENDIX B

This study is aimed at the prevention of pit and fissure caries. The history of the prevention of pit and fissure caries is therefore briefly outlined in the next section.

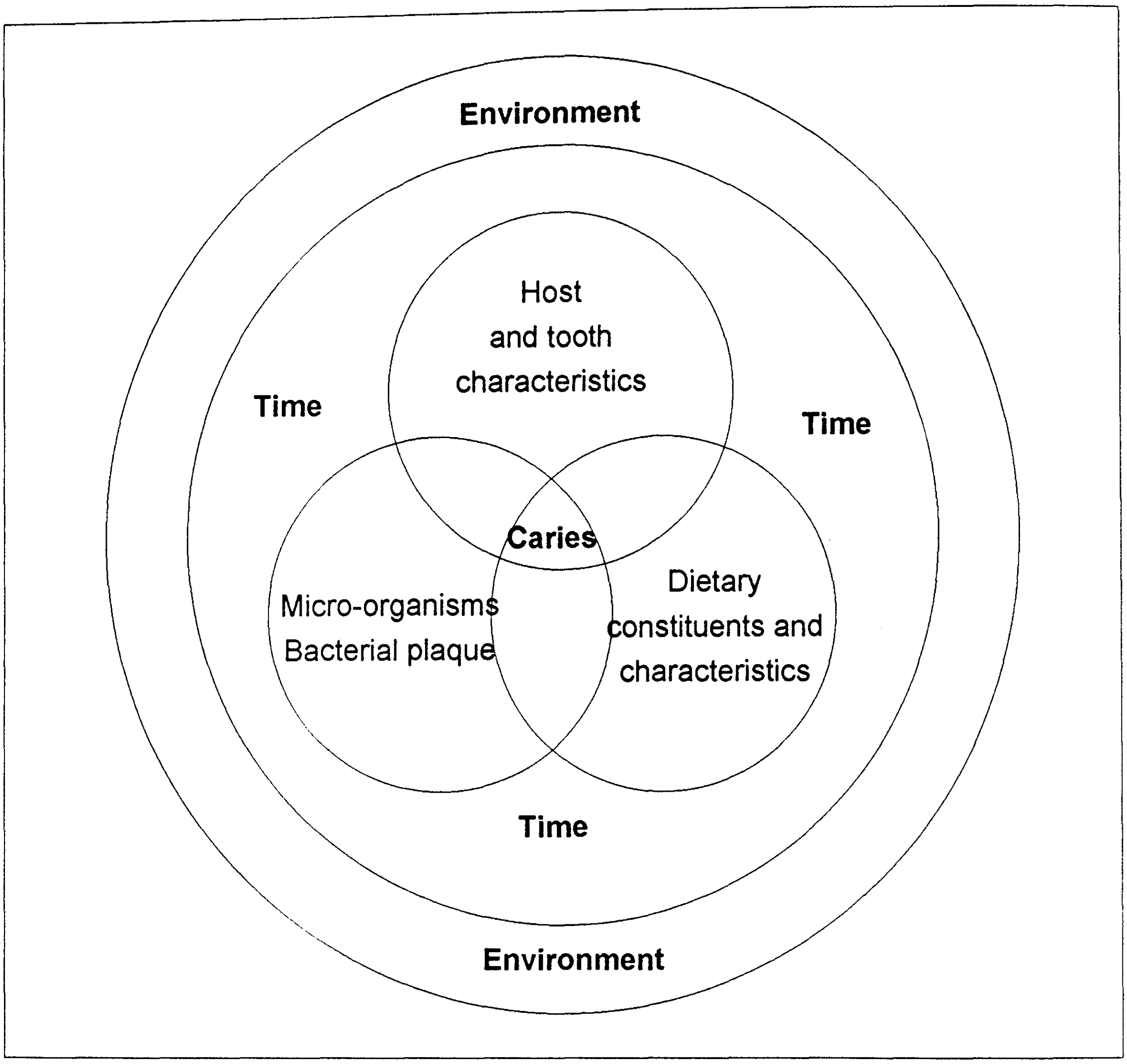

Figure B.1: Diagram showing the interaction between host, micro-organisms, diet, time and the environment (Elderton, 1990, p 144).

3. History of prevention of pit and fissure caries

Several solutions have been suggested through the years to deal with caries of deep pits and fissures. They are :

1. Bödecker (1929, p 859) suggested that deep pits and fissures could be broadened with a large round bur to make the occlusal areas more self-cleansing - a procedure that is called enameloplasty. The two major disadvantages of enameloplasty are firstly the fact that it requires a dentist which limits its utilization and secondly more sound tooth structure is often removed than would be the case with the placement of a small amalgam filling.

2. Hyatt (1936, p 353) advocated the placement of a small restoration in deep pits and fissures before caries had the opportunity to develop.

3. Various attempts to seal or to make fissures more resistant to caries were unsuccessful. These attempts have included the use of topical applied zinc chloride and potassium ferrocyanide (Ast, *et al,* 1950, p 437), ammoniacal silver nitrate (Klein and Knutson, 1942, p 1420) and copper amalgam packed into the fissures (Miller, 1951, p 92).

4. Fluorides that offers optimum protection to the smooth surfaces of teeth are less effective in protecting the occlusal surfaces (Backer-Dirks *et al,* 1961, p 284).

5. Another course of action to deal with pit and fissure caries is the one most often utilized : do nothing; wait-and-watch. This approach avoids the need to cut healthy tooth structure until a definite carious lesion is diagnosed. On the other hand it results in many teeth being lost when patients do not return for periodic check-ups.

6. In the late 1960s and early 1970s, another option became available - the use of pit and fissure sealants (Lee and Swartz, 1971, p 133; Buonocore, 1970, p 324). The one year results of the first clinical trial of dental sealants were reported by Cueto and Buonocore (1965, p 137) in 1965. This report presented a unique new caries prevention method to the dental profession and initiated the current era of acid etch dentistry.

Since fissure sealants are intended to prevent dental caries and particularly pit and fissure caries, the next section explores the caries status in a few developed communities.

4. Caries status

The world-wide status of dental caries in a few developed countries with regard to prevalence and distribution, is briefly reviewed.

4.1. Prevalence

Recent epidemiological reports from Canada (Ontario, 1984, p 9), the United States of America (Brunelle and Carlos, 1982, p 1346) and other developed countries (Anderson et al, 1982, p 1311) indicate a decline in the prevalence of dental caries. These authors specifically noted the increase in the percentage of caries-free children. Johnson (1991, p 148) however indicated that although the percentage of caries free children increased at the age of twelve, less than 20% are caries free at the age of 17.

4.2. Distribution

Based upon a review of caries prevalence reports published before 1970 Ripa (1985, p 367) stated that although occlusal surfaces represented only 12,5 % of the total surfaces of the permanent dentition, they accounted for approximately 50 % of the caries in school children.

Although the caries status in developed communities poses the question whether or not fissure sealants are still relevant in these communities, Ripa (1985, p 368) justified their use by analysis of data from the United States.

5. Need for sealants

In the light of the precipitous decline in dental caries, the current initiative may appear to be anachronistic. The need for sealants can however be justified by a more perceptive critique of the caries activity in children. Ripa (1985, p 368) stated that scrutiny of the data from the United States leads to the following conclusions which have extreme implications for the use of sealants :

5.1. The caries decline is not uniform for all tooth surfaces.

Ripa (1985, p 368) presented data in Table B.1 on the disparate carious surface decline.

	1971-74	1979-80	Change	% Change
Proximal	1,7	0,8	-0,9	-52,9
Buccal-lingual	1,9	1,4	-0,5	-26,3
Occlusal	3,5	2,6	0,9	-25,7

Table B.1: Mean caries prevalence (DMFS) of specific tooth surfaces in United States School children

It is clear that there has been a decrease in the DMFS on all three surfaces. Bucco-lingual and occlusal caries have however decreased by only 26% in comparison with the 53% of proximal surfaces. Occlusal caries always involves pits and fissures, and bucco-lingual caries is mostly found on the buccal pits and lingual grooves of mandibulary and maxillary molars respectively; it is apparent that additional protection is needed for pits and fissures.

5.2. The relative distribution of caries on different tooth surfaces has changed, resulting in a percentage increase of pit and fissure caries.

The unequal reduction in dental caries of the different tooth surfaces alters, according to Ripa (1985, p 368), the relative distribution of decay (Table B.2).

	1971-74 (%)	1979-80 (%)
Proximal	24	17
Buccal-lingual	27	29
Occlusal	49	54
TOTAL	100	100

Table B.2: Relative distribution of caries in specific tooth surfaces of United States school children

The caries of proximal surfaces decreased from 24% in 1971-74 to 17% in 1979-80. On the contrary, the percentage of both occlusal and bucco-lingual caries increased. Due to this change we can argue that dental caries in children has become primarily a disease of pits and fissures (Bohannen and Bader, 1984, p 229).

5.3. The percentage distribution of caries by tooth surfaces is similar in optimally fluoridated and fluoride-deficient communities.

Ripa (1985, p 369) presented the Table B.3 which supports the use of sealants for children in both fluoridated and fluoride-deficient communities.

	Fluoridated communities	Fluoride-deficient communities
Proximal	6	11
Buccal-lingual	40	35
Occlusal	54	54
TOTAL	100	100

Table B.3: Relative distribution of caries in specific tooth surfaces of United States School children from optimally fluoridated and fluoride-deficient communities

Ripa (1985, p 368) stated that although the number of lesions in fluoridated communities was 35% less than in fluoride-deficient ones, the surface distribution was very similar. 94% of the caries in fluoridated communities was pit and fissure caries, while for the fluoride-deficient communities this figure was 89%.

5.4. The number of children experiencing dental decay still remains high, despite a decrease in the number of lesions expected.

According to Ripa (1985, p368) 37% of the United States children between the ages of five and seventeen were caries free in the 1979-80 survey. Age analysis of this data however shows, while 56,7% of elementary school children had a caries free permanent dentition, only 17,2% of the 12 to 17 years were without dental decay. By the age of seventeen only 11% were caries free. This decline in caries free children is caused by decay of the pits and fissures, indicating the need for fissure sealants despite the decline in the prevalence of dental decay.

From this discussion we can conclude that fissure sealants are still a relevant preventive approach despite the decline in dental caries. Fissure sealants were originally used only on healthy pits and fissures in order to prevent these pits and fissures from becoming decayed. The past five to ten years however have seen an increase in their use.

6. Uses of fissure sealants

According to Eccles (1989, p 51) fissure sealants can be used in different ways, namely: a preventive measure; a therapeutic measure; a preventive resin restoration (PRR); and preventive glass ionomer restoration.

6.1. A preventive measure.

This is the traditional way of preventing pit and fissure caries with a resin sealant.

6.2. A therapeutic measure.

This measure treats early pit and fissure caries. According to Eccles (1989, p 51) it is inevitable that sealants will on many occasions be applied inadvertently to early carious lesions, but the reported success rates are excellent despite this "sealing" of caries.

6.3. Preventive resin restoration (PRR).

According to Simonsen (1978, p 70) a preventive resin restoration is the restoration of a small carious lesion (no dentine caries) with the minimum of tooth removal and simultaneously preventing caries attacking other pits and fissures on the same surface. The material used is a resin sealant. This approach eliminates the problems of treating pit and fissure caries with amalgam, namely:

1. The removal of healthy tooth structure due to "extension for prevention"
2. Secondary caries that attacks the margin of the amalgam restoration
3. Marginal leakage
4. Marginal breakdown
5. Aesthetics

These problems frequently result in severe weakening of the tooth. Many of these teeth become destined for full crowns.

6.4. Preventive glass ionomer restorations.

Eccles (1989, p 51) suggests that for small occlusal cavities, where the carious lesion has extended into dentine, a glass ionomer may be used with a fissure sealant covering it.

According to Mitchell and Murray (1989, p 23) fissure sealants are unlikely to be economically viable if applied to teeth that were not liable to become carious. This statement indicates that the selection of teeth to be sealed is of major importance in any oral health care delivery system.

7. Indications for use (Criteria)

The literature reveals three approaches in deciding whether to seal or not. These approaches are patient oriented, tooth oriented and combined patient-tooth oriented.

A patient oriented approach is discussed by Simonsen (1984, p 43) who recommends dividing patients into three groups :

1. Group 1

   Caries-free patients judged at no risk to decay
2. Group 2

   Patients judged to be at moderate risk to decay
3. Group 3

   Patients with rampant caries at high risk to decay

Simonsen (1984, p 43) recommended sealing all the teeth of the children in group 2, but not those in groups 1 and 3. This approach is criticized for possible under- and over-treatment depending on the circumstances.

Another approach to sealing is one that considers all children for a possible sealant. The rationale for this approach is the fact that between 89 and 94 percent (Ripa, 1985 p. 368) of all caries activities involves pits and fissures and that only 11% of seventeen year olds are caries free. Once this concept is accepted, the decision whether to seal is no longer made at patient, but at tooth level.

Ripa (1985, p. 369) described tooth oriented criteria. These criteria are based upon the visual-tactile inspection of teeth. Table B.4 presented by Ripa (1985, p. 369) summarizes the different considerations applicable to tooth oriented criteria.

Surface Diagnosis	Clinical Considerations	Seal	Do not seal
Carious	Occlusal anatomy	If pits and fissures are separated by transverse ridge, a sound pit or fissure may be sealed	Carious pits and fissures
Questionable	Status of proximal surfaces	Sound	Carious
	General caries activity	Many occlusal lesions, few proximal lesions	Many proximal lesions
Sound	Occlusal morphology	Deep, narrow pits and fissures	Broad well-coalesced pits and fissures
	Tooth age	Recently erupted teeth	Teeth caries-free for four years or longer
	Status of proximal surfaces	Sound	Carious
	General caries activity	Many occlusal lesions, few proximal lesions	Many proximal lesions

Table B.4: Tooth oriented Indications and Contra-indications for the use of pit and fissure sealants.

Applying these criteria can be very complex. The evaluation of the tooth starts at the surface diagnosis and moves to the clinical considerations.

A third approach which combines the patient- and tooth level approaches, was developed by the Department of Community Dentistry, Dental Faculty, University of Pretoria. This approach evaluates the three important factors namely caries-risk, tooth age and tooth morphology. The diagram presented in Figure B.2 was developed for field use and provides an easy decision-flow model.

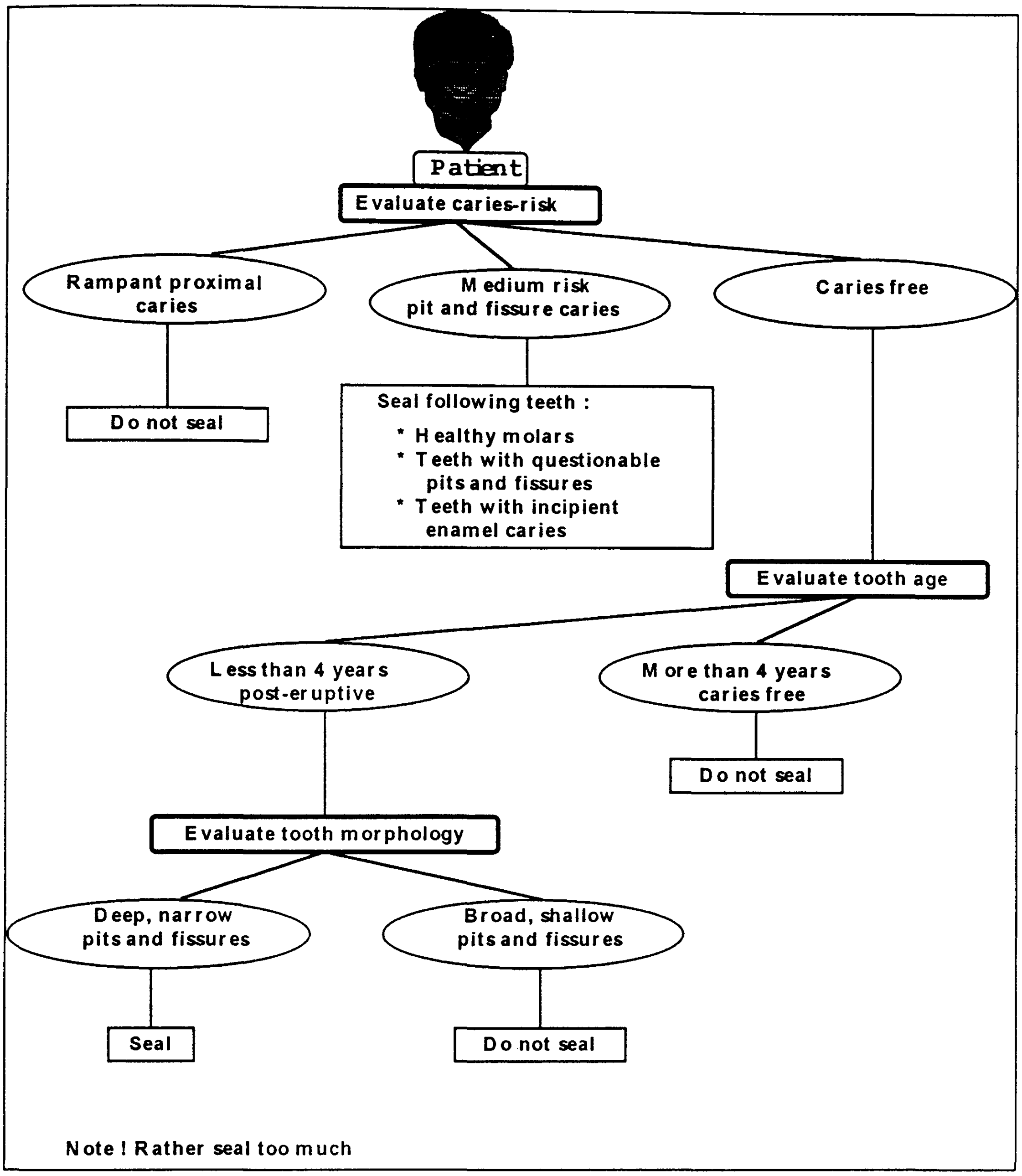

Figure B.2: A decision flow-diagram (to decide whether to seal or not) developed for field use.

In the following few sections issues relating to the use and implementation of pit and fissure sealants are discussed.

8. Technique

The clinical technique is critical for sealant performance. Success or failure depends on the proper completion of a series of important steps. Ripa (1985, p. 372) stated that the retention reported in various studies was undoubtedly due, to a large extent, to the influence of the clinical technique on the adherence of the sealants. The critical factors of success are etching, contaminate-free enamel surface and a dry field of operation.

9. Time required

Horowitz *et al* (1974, p 885; 1977 p 1133) showed that for children aged 5 to 8 years an average of 9,6 minutes was required to seal teeth in one side of the mouth, while for children aged 10 to 13 years an average of 12 minutes was required to seal about three times more teeth. In a study by Cons *et al* (1976, p 14) hygienists with assistants required 8 minutes to place a single sealant and 15 minutes to place sealants in two first molars. In the study of Cons *et al* time was measured by recording the number of minutes elapsed from the moment children were seated for treatment until they were dismissed. Roder and Sundrum (1976, p 491) reported that it required a longer time for etching and sealing teeth in fluoridated than in non-fluoridated communities.

10. Manpower

Leake and Martinello (1976, p 409) concluded that the cost of applying a sealant to the occlusal pits and fissures of two first molars was much greater for children treated by a dentist ($13,08 per patient) than by a dental hygienist ($7,63 per patient). The same authors however found that the sealants placed by the dentist had a better rate of retention and were more effective in preventing tooth decay than were those of the dental hygienist. It is however emphasized that only one dentist and oral hygienist participated in this study.

11. Materials

Most of the current fissure sealants have a basic formulation of dimethacrylates (Ripa, 1985, p. 370). The commercial products differ in several aspects : some are unfilled while others contain filler particles; they may be clear, tinted or opaque; and some set by a chemical reaction while others are photo-initiated with either visible or ultraviolet light. Sealants are packaged with an etchant solution of phosphoric acid of which the concentration may differ between 37 and 50 percent.

In "real life", health care organizations have to decide how to manage occlusal caries. A brief discussion on the subject which has been covered from various angles by different researchers follows next.

12. Sealants versus amalgams

According to Ripa (1985, p.374) sealants and amalgams should be regarded as alternative treatments since sealants are used to prevent teeth from becoming carious while amalgam restorations are used to restore teeth after caries has occurred. The fact however is that dental services often decide to use a one-surface amalgam instead of a sealant because amalgams allegedly can be placed in less time and once placed are a permanent restoration. Therefore Burt (1984, p. 96) indicates that it is legitimate to compare these two. The two major obstacles (it takes *less time* to do an amalgam and an *amalgam is a permanent* filling) in the wider use of sealants have been addressed by several studies.

The *time* issue was addressed by Burt (1984, p 96) and Dennison and Straffon (1984, p 215). They indicated that sealants required approximately 6 to 9 minutes to place and amalgams 13 to 15 minutes.

Elderton (1983) indicated that *restorations were* often *not very durable.* He found the median survival time for routine restorations in adults to be approximately 5-10 years. Restorations that are judged to be unsatisfactory are usually replaced with bigger restorations which further weaken the tooth. Elderton (1983) also states that the original errors in the failed restorations are often repeated, which lead to further failures.

A last element to receive attention is the evaluation of pit and fissure sealants. This evaluation includes the efficacy, effectiveness and efficiency of sealants in oral health care settings.

13. Evaluation

13.1. Efficacy

Ripa (1980, p 127; 1983, p 216), Gwinnett (1982, p 298) and Silverstone (1983, p 44) indicated the safety and efficacy of fissure sealants. In America a National Institutes of Health Consensus Development Panel has affirmed the safety and efficacy of the technique. Ripa (1985, p 370) indicated a difference in the clinical efficacy of auto-polimerized sealants compared to those initiated with ultraviolet light. Rossouw (1990, p 10) indicated the efficacy of sealants and sealant programmes for developing communities in Southern Africa.

13.2. Effectiveness

Ripa (1985, p 370) stated that because fissure sealants were effective as long as they remained firmly attached to the tooth, an assessment of their clinical success included clinical retention and occlusal caries reduction. Weintraub (1989, p 319) evaluated sealant effectiveness by four criteria, namely: (1) the percentage effectiveness; (2) the percentage retention; (3) the percentage sealed teeth becoming carious; and (4) re-application rates. Simonsen (1987, p 33 and 1991, p 39) added, to this list of Weintraub, the reduction of risk via the Odds ratio.

13.2.1. Clinical retention

Sealants have no active ingredients (Ripa, 1985, p 370). The prevention of tooth decay is achieved by the bonding to the enamel surfaces and the physical isolation of the pits and fissures from the rest of the oral environment. For sealant retention it is important that the surface of the tooth (1) have a maximum surface area, (2) have deep, irregular pits and fissures, (3) be clean and (4) be absolutely dry. The longevity of a sealant on a tooth (retention) is thus the prime determinant of sealant success. First generation studies by Mertz-Fairhurst (1984, p 18) and Rock (1984, p 27) have shown that effectiveness (caries inhibition) was a direct function of sealant retention. Ripa (1985, p 371-372) reports the retention rates in Table B.5 from 67 independent sealant studies.

Study	Years after sealant application	Percent retention
Stephen *et al*	1	100
Simonsen	1	96
Furguson & Ripa	1	88
Thylstrup & Poulsen	1	73
Stiles	1	51
Whitehurts & Soni	1	18
Simonsen	2	96
Stephen	2	83
Horowitz *et al*	2	73
Poulsen *et al*	2	58
Burt *et al*	2	27
Higson	2	3
Simonsen	3	94
Richardson *et al*	3	75
Harris *et al*	3	37
Williams & Winter	4	88
Richardson *et al*	4	69
Leake & Martinello	4	22
Gibson *et al*	5	67
Richardson *et al*	5	19

Table B.5: Sealant retention rates as reviewed by Ripa (1985, p 370)

Ripa (1985, p 370) states that there are 150% more reports on sealant retention than on caries inhibition. He attributes this to the positive results on sealant efficacy, which lead investigators to the feeling that children should not be denied the caries-preventive benefits of sealants. The half mouth studies, in which the one side of the mouth were sealed and the other side were left untreated, are not justified any more. In whole mouth studies where the children receive the maximum benefits from participating in the programme, sealant success is based on retention.

According to Going (1984, p 35-41) it is not clear whether a tooth that lost its sealant after ten years behaves like a mature tooth less prone to decay, or as a newly erupted tooth unprotected for the first time. Silverstone (1983, p 205) however indicated that although a sealant was totally lost there was still a preventive action due to the resin residue filling the micro-tubuli.

13.2.2. Determination of the occlusal caries reduction associated with their use.

Studies testing the caries reduction potential of sealants usually compare sealant-treated teeth to contra-lateral untreated teeth in the same mouth. Thus, all the teeth are exposed to the same intra-oral risks. The teeth are evaluated as treatment-control pairs, and an index called "net gain" is used to analyze the treatment effectiveness of the sealant. The method acknowledges that there are four possible outcomes for each tooth pair, namely :

1. Treated sound and control carious.
2. Treated carious and control carious.
3. Treated sound and control sound.
4. Treated carious and control sound.

The "net gain" is the total number of teeth estimated to have been saved from caries by the sealant. It is calculated by the following formula.

"Net gain"	=	Treated sound, control carious pairs - treated carious, control sound pairs

The caries reduction ability has also been evaluated by the "percent effectiveness" method. It is calculated by the following formula :

Percent effectiveness = (Net gain/Number of carious control teeth) x 100%

Table B.6 presents the results of caries reduction studies (Ripa, 1985, p 371).

Study	Years after sealant application	Percent effectiveness
Buonocore	1	100
Bojanini *et al*	1	91
Low	1	82
Thylstrup & Poulsen	1	70
Rock	1	65
Buonocore	2	99
McCune *et al*	2	93
Low	2	77
Horowitz	2	67
Higson	2	23
Burt *et al*	2	14
McCune *et al*	3	85
Bagramian	3	73
Brooks	3	69
Rock & Bradnock	3	36
Richardson *et al*	4	62
Horowitz *et al*	4	45
Leake & Martinello	4	22
Gibson *et al*	5	51
Bagramian	5	17-32

Table B.6: Caries reduction rates as reviewed by Ripa (1985, p 373)

The results of these studies varied with the type of teeth sealed, their post-eruptive age and morphology, and the application techniques used.

There are however, many factors that influence this specific calculation of percent effectiveness (percent caries reduction). If the caries rate in communities are very low, many of the control teeth would remain sound. Even if the sealants were 100% effective in preventing caries and most of the control teeth remained sound, the net gain would approach zero. If all the sealed teeth remained sound, the percent effectiveness will always be 100%

as long as at least one surface of the control group decays. Given the current lower caries rates, the actual absolute reduction is important to monitor as well as the percent reduction in occlusal caries due to the fissure sealant. According to the law of diminishing returns a point of no return will be reached.

Heidmann, Poulsen and Mathiassen (1990, p 387) evaluated the caries reduction in a longitudinal study by calculating the reduction in DMFS. The percentage effectiveness (percentage caries reduction) is then calculated as follows.

$$\text{Percentage effectiveness} = \frac{\text{Reduction in DMFS}}{\text{Baseline DMFS}} \times 100$$

13.2.3. Caries status of sealed teeth.

Table B.7 presents the results from studies on the percentage of sealed first molars becoming carious and/or restored by length of time since the sealant application (Weintraub, 1989, p. 326).

	Number of years						
Author	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Thylstrup	8	14					
Gibson	5	7	17	21	26		
Mertz-Fairhurst	-	11	13	24	-	29	31
Vrbric	2	10	19	27	37		
Median	4	7	13	24	25	27	31

Table B.7: Percentage of first molars becoming carious and restored after sealant application as reviewed by Weintraub (1989, p 326)

The results of this table indicate that sealants need to be reapplied if their beneficial effect is to be maintained.

13.2.4. Re-application rates.

Re-application rates have been reported by some researchers that have included re-application of sealants in their programmes. Whyte *et al* (1987, p177) reported a cumulative rate of 6,6 percent of 11237 teeth sealed after two years. The resealing rates after one year were reported by age. The rate for 5-7 years was almost twice as high, 6,2%, as the rate for 8-15 years, 3,3%. Weintraub *et al* (1989, p 212) reported a re-application rate of 25% after 5,8 years.

13.2.5. Correlation between percentage effectiveness and percentage retention.

Weintraub (1989, p 326) used the graph in Figure B.3 to indicate the relationship between sealant percentage effectiveness and percentage retention.

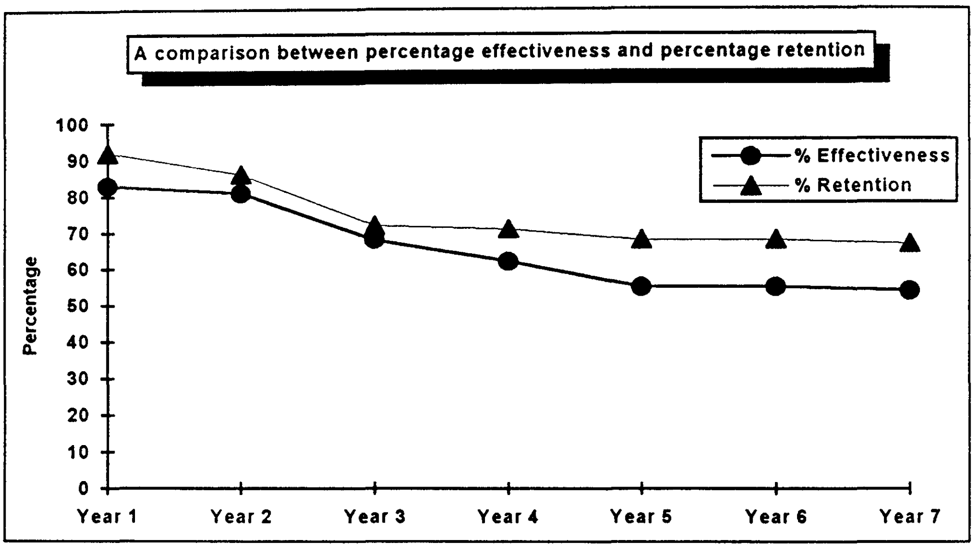

Figure B.3: A comparison between the percentage effectiveness and the percentage retention (Weintraub, 1989, p 326)

It is clear from the graph that there is a strong correlation between % effectiveness and % retention, the difference between the two being a value possibly due to the sealing of teeth not prone to caries, which again emphasizes the need for selection criteria.

13.2.6. Reducing caries risk

Simonsen (1987, p 33 and 1991, p 39) used the Odds ratio to determine the risk for a non-sealed tooth to develop caries compared to a sealed tooth. Simonsen calculated a risk for a non-sealed tooth to become carious compared to a sealed tooth as 9:1 and 7,5:1 ten and fifteen years after a single application of fissure sealant respectively.

13.3. Efficiency

Fissure sealant literature predominantly uses the terms cost-effectiveness, benefit to effort ratio and cost benefit analysis.

13.3.1. Cost-effectiveness

Ball (1986, p 383), Ripa (1985, p 374), Horowitz (1980, p 118), Mitchell and Murray (1989, p 21) and Eklund (1986, p 136) state that the cost-effectiveness of fissure sealant programs are mainly influenced by the following factors:

1. The kind of manpower used.
2. The number of teeth sealed per mouth.
3. The selection of at risk patients and teeth.
4. The retention rate of the sealants.
5. The time used for the placement.
6. The kind of sealant used.
7. Materials and equipment.
8. Operator technique.
9. Durability.
10. Monitoring.
11. Use of other preventive techniques.
12. The level of caries in the population.

Ripa (1985, p 375) found that the cost of sealing a single tooth is 47% less than the cost of the placement of a one-surface amalgam restoration. Horowitz (1980, p 120) indicated that the cost of placing fissure sealants is one-half that of placing amalgams if dentists perform both services. If dental auxiliaries however place sealants, he concluded that the cost of the placement of a sealant is one-sixth that of the cost of dentists placing amalgam restorations. Simonsen (1989, p 75) indicated that the cost to maintain a group of unsealed children is 1,64 times higher than that of a sealed group. Hartshorne and Carstens (1989) indicated the following costs for sealant and restorations:

	Cost per tooth (R)
Routine sealing by hygienist	3,02
Routine sealing by dentist	5,58
Occlusal amalgam by dentist	10,54

According to Elderton (1990, p 250) it is important to note that not every tooth receiving a sealant would necessarily become carious. The cost of preventing a single carious lesion is thus greater than the cost of a single application. Elderton (1990, p 250) concluded that sealants would be most cost-effective if they could be placed over only those teeth that would become carious.

13.3.2. Benefit to effort ratio

In the case of fissure sealants this ratio indicates the number of sealants needed to prevent 1 amalgam filling. Heidman, Poulsen and Mathiassen (1990, p 381) indicated benefit to effort ratios of 1:5 and 1:8 for girls and boys respectively. Leverett *et al* (1983, p 39) indicated that five sealants would be necessary to prevent one carious lesion over a five year period. Rock (1984, p 29) calculated a one in three prevention rate. Simonsen (1991, p 39) indicated a ratio of 1:1,9 in a fifteen year evaluation study. Simonsen (1991, p 41) emphasized the fact that if only at risk teeth could be sealed this ration would be close to 1:1.

13.3.3. Cost-benefit

Ripa (1985, p 375) stated that it is difficult to account the many intangible benefits of a sealant programme, such as: maintaining a tooth free of caries; reducing and eliminating pain and discomfort associated with a diseased tooth; preventing the weakening of tooth structure; and reducing the time lost from school and the workplace as parents accompany their children on dental appointments.

14. Summary

This review of the research literature indicates the feasibility, efficacy and largely the effectiveness of fissure sealants from a purely scientific perspective. The efficiency of sealant programmes in oral health care settings is however not clear yet. The problem is possibly embedded in the fact that scientific evaluation tends to operate in relative isolation. A wider, wholistic or systems approach is probably needed to give real life perspective to the evaluation of sealants in health care organizations.

APPENDIX C

REVIEW OF THE LITERATURE ON PERFORMANCE MEASUREMENT

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APPENDIX C

REVIEW OF THE LITERATURE ON PERFORMANCE MEASUREMENT

1. Introduction

Expanding populations, demands for higher living standards, and consistent if not declining resources pose the question of productivity to the world and more specifically to South Africa. How will more people live on a higher standard of living with the same or less resources if management strategies fail to do more with less. This review on performance measurement starts with a section on productivity indicators and the productivity dilemma in South Africa. The definition of productivity is discussed from the management literature, whereafter some misperceptions about productivity due to some of the rigid definitions are stated. With this general background to the concept some thoughts about productivity in health care are pondered. The objective of performance assessment is discussed, whereafter some conceptual components and strategies regarding productivity improvement are presented. To assess and improve performance the manager needs tools; a wide discussion of available tools is offered. The review then poses a general perspective on the implementation of productivity measurement tools. The final section of the review focuses on the Objectives Matrix as a measurement tool. Management by Objectives as the foundation of the Objectives Matrix is briefly deliberated, whereafter the Objectives Matrix *per se* is deliberated under the headings: advantages, and development and implementation.

This review of the literature on productivity and performance measurement follows the framework as indicated in Figure C.1.

2. Productivity indicators and productivity dilemma in South Africa

On a national level, productivity is most commonly measured by the comparison of gross domestic product (GDP) per employee (Campbell *et al,* 1988, p 17). According to Du Plessis (1981, p 112) South Africa has the worst productivity situation in the developed world. Du Plessis (1981, p 112) stated that the productivity in South Africa increased with only 0,21% per annum between 1972 and 1979, while Japan increased their productivity with 3,35% per year over the same period. Table C.1 from the President's Council (1989, 34) compares the GDP growth rate percent per annum between a few countries and South Africa.

APPENDIX C

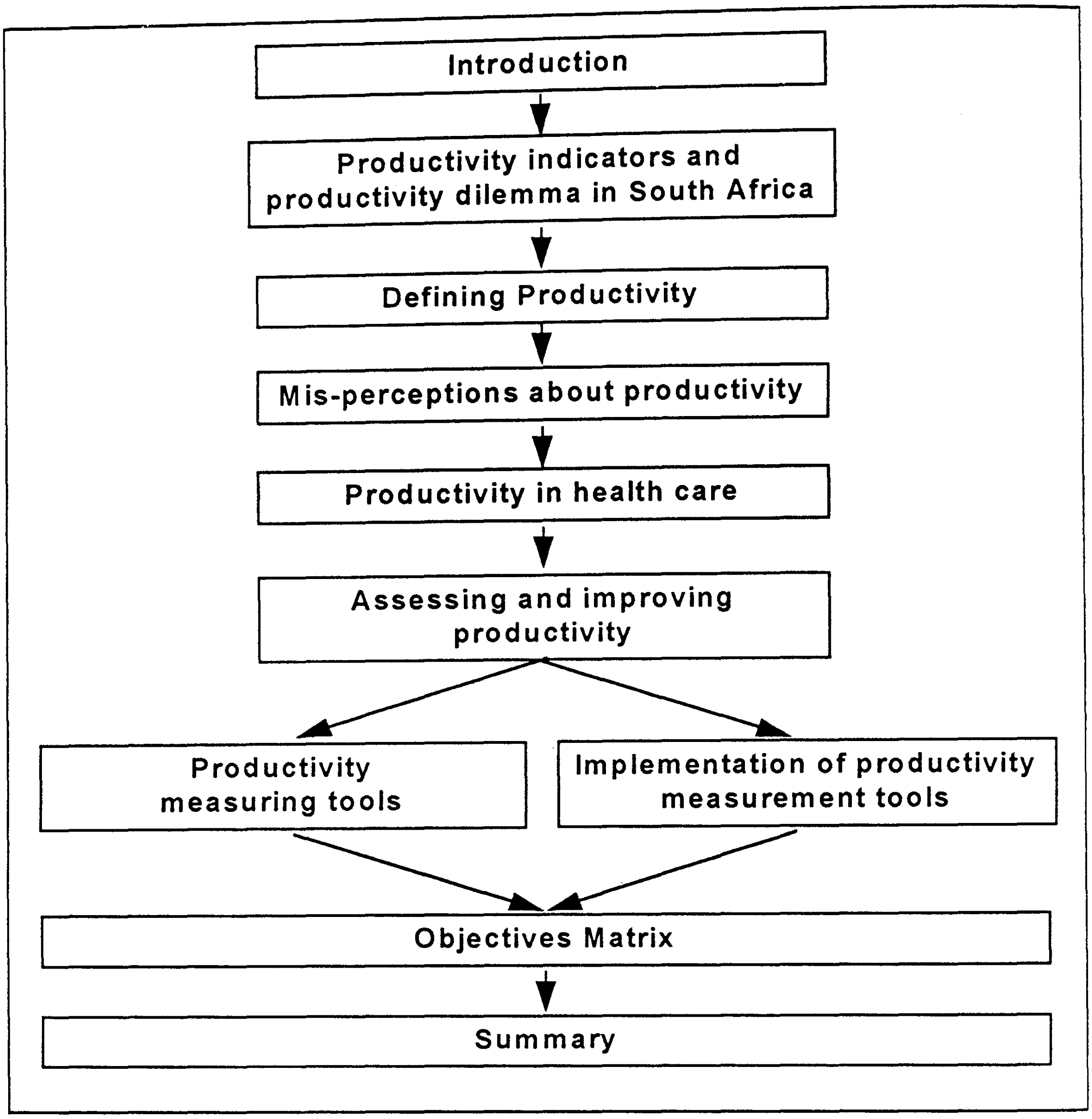

Figure C.1: Framework of the literature review on productivity and performance measurement.

Countries	1963-1972	1972-1980	1980-1984
South Africa	2.4	0.9	-0.8
Argentina	2.2	0.6	-3.1
Australia	3.5	1.5	1.4
Canada	3.7	3.1	1.0
Germany	3.7	2.5	1.1
India	0.9	1.7	1.7
Japan	9.6	3.1	3.1
Malawi	2.9	1.2	-1.7
New Zealand	2.1	0.1	1.7
Spain	5.4	2.0	1.4
United Kingdom	2.3	1.8	1.2
USA	2.6	1.5	1.3
Zaire	1.6	-2.0	-2.0

Table C.1: A comparison of the GDP growth rate percent per annum between known economies.

On a corporate level productivity is commonly measured by using different measures, indices and ratios. Campbell *et al* (1988, p 19) listed the following measures of productivity used by managers.

Measures:

Profit
Customer satisfaction
Sales, revenues
Market share
Costs
Quality, defects
Response time
Units produced

Indices:

Sales 1990/Sales 1989
Labour costs 1990/Labour costs 1989
Activities 1990/Activities 1989

Ratios:

Return on investment
Net earnings per share
Labour cost per unit produced
Profit per sales dollar
Actual output/Planned output
Production cost/Standard cost
Labour hours/Standard hours
Output per employee

In the new dispensation envisaged for South Africa the need for improvement in productivity should be first on the national agenda (De Wit and Hamersma, 1992, p 202). The same resources will have to be used more creatively, effectively and efficiently in order to increase the output needed to meet the astronomical expectations with regards to greater prosperity among the majority of the country's inhabitants.

Having established the productivity crisis in the world and specifically in South Africa, as well as some criteria, indices and ratios used as indicators, the deliberation moves to explore the definition of productivity.

3. Defining productivity

The concept productivity has captured the attention of many in our society (Campbell *et al,* 1988, p 13). One finds references to productivity in publications ranging from management textbooks to journals in the natural sciences. To indicate some of the differences and common ground between the definitions stated by authors, a few possibilities are stated below:

Campbell *et al,* 1988, p 18:

> *"**Productivity** is an efficiency concept generally cast as a ratio of output relative to input into some productive process. ..... Productivity is also a performance variable and is perhaps best illustrated in comparison with other performance variables."*

From this definition it is clear that Campbell *et al* see productivity only as efficiency. Their view is clarified by the fact that their base of reasoning starts in the economic sciences.

Stoner and Freeman (1992, p 634):

> *"Measure of how well an operations system functions and indicator of the **efficiency** and **competitiveness** of a single firm or department. (The underlying assumption is that the majority of goods meet pre-established standards for **quality**)*

From this definition it is clear that Stoner and Freeman includes three variables in their definition, namely: [1] Efficiency; [2] Effectiveness (competitiveness); and [3] Quality.

De Wit and Hamersma (1992, p 202):

> *"Productivity refers to the ability to achieve production. Simply defined, productivity is measured by the following quotient:"*

$$\text{Productivity} = \frac{\text{Product (output) quantity}}{\text{Resource (input) quantity}}$$

De Wit and Hamersma again only focus on efficiency, except if the *product* implies that it is effective. They however do not include quality in their definition.

Koontz and Weihrich (1988, p 8):

> *"Productivity is the output-input ratio within a time period with due considerations for quality. Productivity implies both effectiveness and efficiency in individual and organizational performance"*

Koontz and Weihrich see productivity as a performance indicator that incorporates effectiveness, efficiency and quality.

Du Plessis (1981, p 111):

> *Productivity consists of five different aspects namely: [1] Efficiency; [2] Effectiveness; [3] Quality; [4] Customer satisfaction; and [5] Employee satisfaction.*

Du Plessis separates customer satisfaction from effectiveness probably due to a lack in systems thinking as a system can only be effective if it addresses the needs of its customers. Du Plessis also identifies employee satisfaction as an important aspect, although behaviourists rather see employee satisfaction as one of the propellant forces behind productivity.

Orbach (1985, p 6):

> *"Productivity is the ability to combine and convert inputs of resources into outputs of goods and services. This ability is a function of three important factors: Utilisation, Efficiency and Effectiveness, which operate individually as well as interdependently."*

Orbach (1985, p6) illustrated his definition of productivity as shown in Figure C.2.

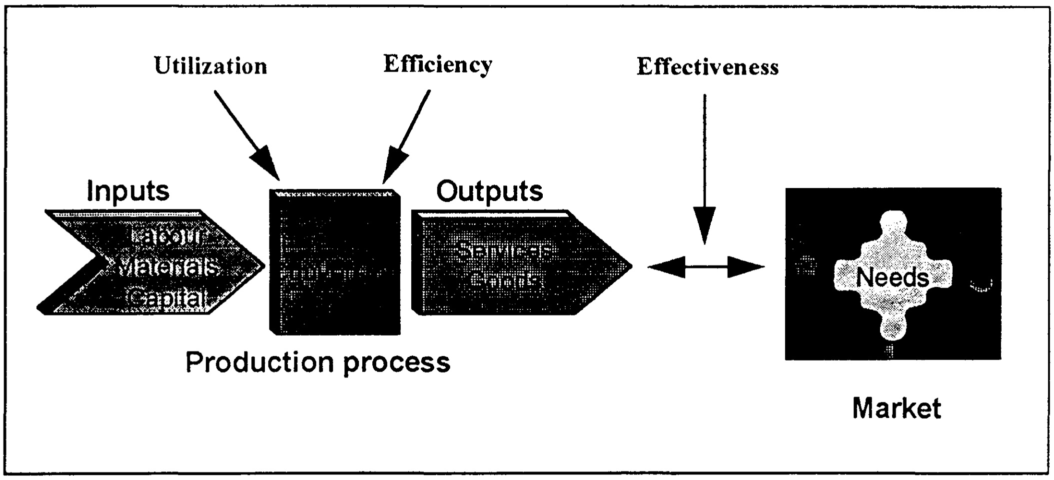

Figure C.2: Illustration of productivity (Orbach, 1985, p 6)

Orbach includes quality of service in effectiveness. He however adds the aspect of utilization which means the optimum use of available resources in the production process.

Presidents council (1989, p 8):

> *"Productivity is the ratio between goods and services produced in the national economy, in an industry or in an individual organization on the one hand, and the resources used to produce them on the other hand, so as*

to indicate the productive efficiency with which labour, capital, materials and other inputs are combined and used to produce goods and services of specific quality for the satisfaction of customer needs."

For the purpose of this study it is accepted that the term productivity includes three performance indicators, namely: [1] Effectiveness, [2] Efficiency (which includes utilization), and [3] Quality.

Due to the inconsistent use in the literature these terms are defined as they will be used in this study.

3.1. Effectiveness

According to the Oxford dictionary (1988, p 308) effectiveness means to have an effect. Koontz and Weihrich (1988, p 8), Kroon (1990, p 7) and Robbins (1988, p7) define effectiveness as the achievement of objectives. According to Stoner and Freeman (1992, p 6) effectiveness means to *"do the right thing"*. Organizations and managers can however be effective without being efficient (Stoner and Freeman, 1992, p 6). Drucker (1964, p 86) emphasizes the importance of effectiveness by labelling it as the key to organizational success.

3.2. Efficiency

The Oxford dictionary (1988, p 308) describes efficiency as the ratio of useful work done to total energy expended. Koontz and Weihrich (1988, p 8), Kroon (1990, p 7) and Robbins (1988, p7) define efficiency as the achievement of ends with the least amount of resources. According to Stoner and Freeman (1992, p 6) efficiency is the ability to *"do things right"*. Organizations and managers can however be efficient without being effective (Stoner and Freeman, 1992, p 6).

3.3. Quality

The Oxford dictionary defines quality as a degree of excellence. According to Marx *et al* (1991, p 342) the term quality does not necessarily mean the highest possible intrinsic quality of a product, but rather the most suitable quality. The most suitable quality is described as that state of quality which can be bought at the lowest possible cost and still achieve the goals. According to Crall (1989, p 673) quality in dental care includes timeliness and appropriateness of treatment, continuity of treatment, emphasis on prevention, and adequate documentation of services provided. Atchinson (1989, p 671) states that the quality of these properties are reflected in the perception and satisfaction of patients towards the health care system.

The key issues in the productivity definition have been identified and described. Some of the rigid definitions about productivity, and the mis-use of it, often lead to some mis-perceptions about productivity. Some of these mis-perceptions are stated in the following section.

4. Mis-perceptions about productivity

According to the President's Council (1989) rigid formulas like, Productivity = Output/Input, lead to mis-perceptions about productivity. A few of these mis-perceptions that should be managed are:

1. Productivity causes a decline in job opportunities.
2. Productivity is a single, non-repeating event.
3. Productivity is the responsibility of only one person.
4. Productivity is only in relation to production.
5. Productivity implies harder work.

This last statement is negated by the following quote:

"*Work smarter not harder*"

Productivity SA

The review has deliberated a few productivity concepts from a purely industrial management perspective. It thus makes sense to present a short but important perspective on the meaning of productivity in health care.

5. Productivity in Health care

According to Helmer and Suver (1988, p 75) productivity analysis in health care stands as a relatively underdeveloped management tool. The problem is probably concealed in the way health systems define their output. If a health system defines its output as merely the treatment of disease, productivity would only mean to treat more disease with the same or less resources. If however the output is defined as health or the effect that the health system has on the health status of the population (WHO, 1985, p 1), then productivity would mean to achieve health *per se* in the most effective, efficient and quality method.

According to Brown and Comola (1988, p 23) about 60% of the budget of any health care system is devoted to personnel. Furthermore, personnel are directly controlling the consumption of the other resources of the health care system. From this follows the reasoning that measuring and controlling personnel in a health care system actually measures and controls the total system.

With this broad background on productivity the objective of productivity assessment is deliberated next.

6. Objective of productivity assessment

It is certain that performance appraisal (productivity assessment) is an essential and therefore widely practised human resource management activity. According to Spriegel (1962, p 80) individual performance data are needed for the following decision making purposes: [1] Employee counselling, [2] Promotions, [3] Training, [4] Development, [5] Salary administration, [6] Bonus payment allocation, [7] Personnel auditing, [8] Potential spotting, [9] Job redesign, and [10] Work motivation. These observations suggest that, for any organisation, there is no question that individual performance data need to be sought; the questions that organizations seek to answer only concern the type and quality of the necessary information as well as the nature of the processes by which data is obtained (Bailey, 1983, p 2).

According to De Wit and Hamersma (1992, p 202) the main objective of all productivity analysis is however, the improvement of productivity.

7. Productivity improvement

Conceptually there are certain components and strategies management should consider if productivity is to be improved.

7.1. Productivity improvement components

According to De Wit and Hamersma (1992, p 202) there are three main components involved in productivity improvement namely: External components; Internal soft components; and Internal hard components. Figure C.3 from De Wit and Hamersma (1992, p 202) illustrates these main components. These components are deliberated in more detail.

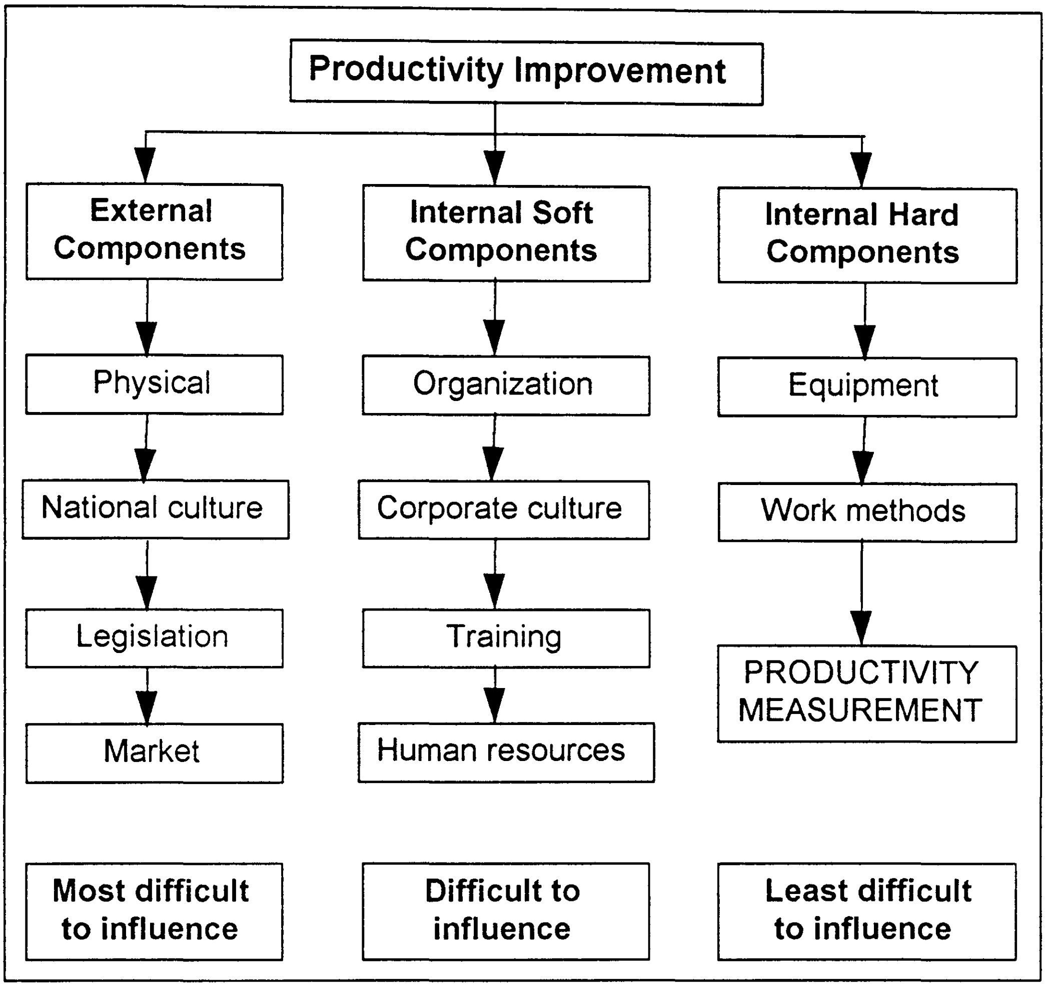

Figure C.3: Components of the productivity improvement process

7.1.1. External components of productivity improvement

According to De Wit and Hamersma (1992, p 203) external components refer to factors beyond the control of management. The physical environment comprises the natural environment. The national culture of a society includes aspects like work ethic and a profit motive. Legislation represents policy instruments like tax reductions, privatisation and deregulation. In the market the size and technological changes can influence productivity.

7.1.2. Internal soft components of productivity improvement

De Wit and Hamersma (1992, p 203) define soft components as intangible factors that are difficult to influence. The important aspects are organizational structure, corporate culture, training programmes and human resources policies. By changing these aspects for the better a significant improvement in productivity can be effected.

7.1.3. Internal hard components of productivity improvement

According to De Wit and Hamersma (1992, p 204) hard components refer to tangible factors that are easy to change. The two important factors are the quality and reliability of equipment and work methods.

7.2. Productivity improvement strategies

According to McAfee and Poffenberger (1983, p 13) there are seven strategies to improve productivity (Figure C.4). The ideal productivity improvement strategy would probably include ideas from all seven these strategies.

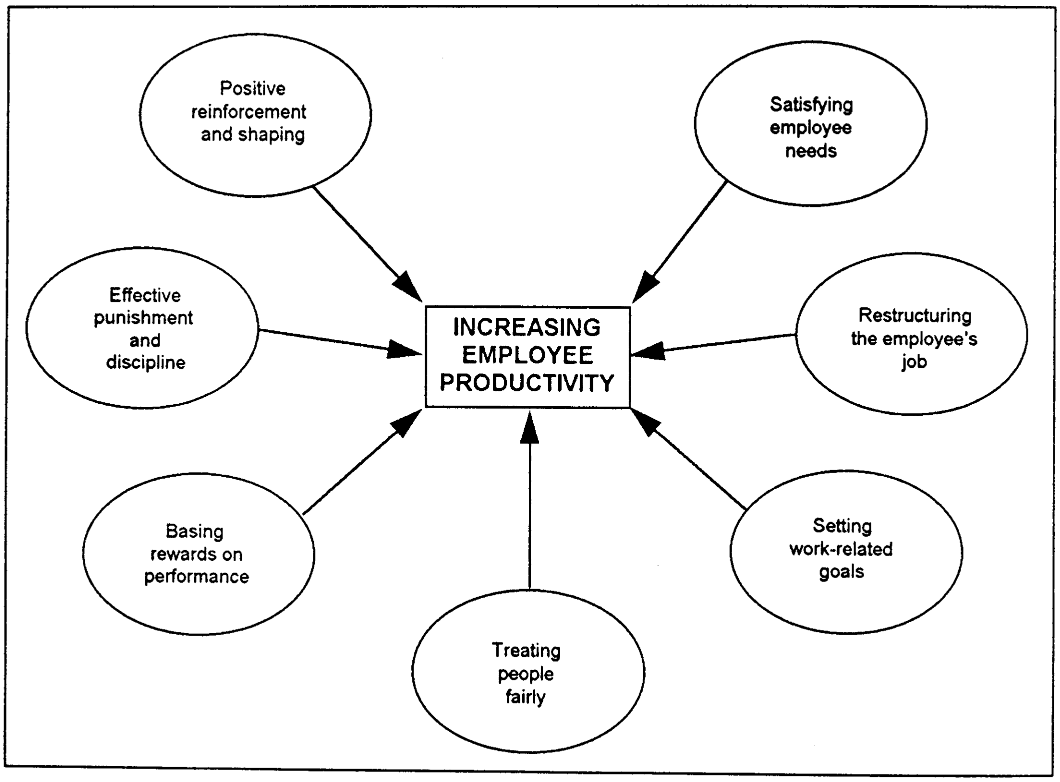

Figure C.4: Strategies to improve employee productivity.

To improve productivity in the workplace the manager needs some measuring tools. The next section presents a broad perspective on the measuring tools available.

8. Productivity measuring tools

According to Bailey (1983, p 4) an effective appraisal system should meet the following five criteria: [1] Validity, [2] Reliability, [3] Discriminibality, [4] Relevance, and [5] Freedom from bias.

Bailey (1983, p 36) identified and classified performance appraisal methods as follows:

1. Closed, Free Expression Reports
2. Individual Standards Procedures
   - ⇨ Management by Objectives
   - ⇨ Performance Review
   - ⇨ Developmental Action Programme
3. Comparative Standards Procedures
   - ⇨ Straight Ranking
   - ⇨ Alternate Ranking
   - ⇨ Paired Comparison
   - ⇨ Forced Distribution
4. Absolute Standards (Qualitative) Procedures
   - ⇨ Critical Incident Technique
   - ⇨ Weighted Checklist
   - ⇨ Forced Choice
5. Absolute Standards (Quantitative) Procedures
   - ⇨ Conventional Rating Scales
   - ⇨ Behavioural Expectation Scales
   - ⇨ Behavioural Observation Scales
6. Performance Tests
   - ⇨ Leaderless Group Discussion
   - ⇨ In-Basket
   - ⇨ Work Sample
7. Direct Indices
   - ⇨ Objective Data
   - ⇨ Personnel Data

Robbins (1988, p 551) and Maartens (1985, p 14) describe the following performance appraisal techniques: [1] Written essays, [2] Critical incidents, [3] Graphic rating scales, [4] Behaviourally anchored rating scales, [5] Multi-person comparison, [6] Group order ranking, [7] Individual ranking, [8] Paired comparison, and [9] Objectives Matrix.

8.1. Written essay

It is a performance appraisal technique in which an evaluator writes out a description of an employee's strengths, weaknesses, past performance, and potential. He then makes suggestions for improvement (Robbins, 1988, p 550).

8.2. Critical incidents

According to Robbins (1988, p 551) it is a technique in which an evaluator lists key behaviours that separate effective from ineffective job performance.

8.3. Graphic rating scales

It is a performance appraisal technique in which the evaluator rates a set of performance factors on an incremental scale (Robbins, 1988, p 551).

8.4. Behaviourally anchored rating scales

It is a performance appraisal technique in which the evaluator rates employees on specific job behaviours derived from performance dimensions (Robbins, 1988, p 551).

8.5. Multi-person comparisons

According to Robbins (1988, p 551) it is a technique in which individuals are compared to one another. The three most common uses of this approach are group order ranking, individual ranking, and paired comparisons.

8.5.1. Group order ranking

This technique groups employees into ordered classifications.

8.5.2. Individual ranking

This technique ranks employees in order from highest to lowest.

8.5.3. Paired comparisons

This technique compares every employee with every other employee and rates it as either the superior or weaker member of the pair.

8.6. Objectives Matrix

According to Maartens (1985, p 14) the Objectives Matrix is a logical and effective method for measuring and improving performance.

These tools *per se* are however not the magic solution to organizational problems. The use and implementation of measurement tools should be managed in order to, hopefully, succeed. A general view on the implementation of productivity measurement tools is presented in the following section.

9. Implementation of productivity measurement tools

According to De Wit and Hamersma (1992, p 204) the implementation of a productivity measurement tool is a process through which management and labour create an irrevocable commitment to productivity improvement. Figure C.5 illustrates this process.

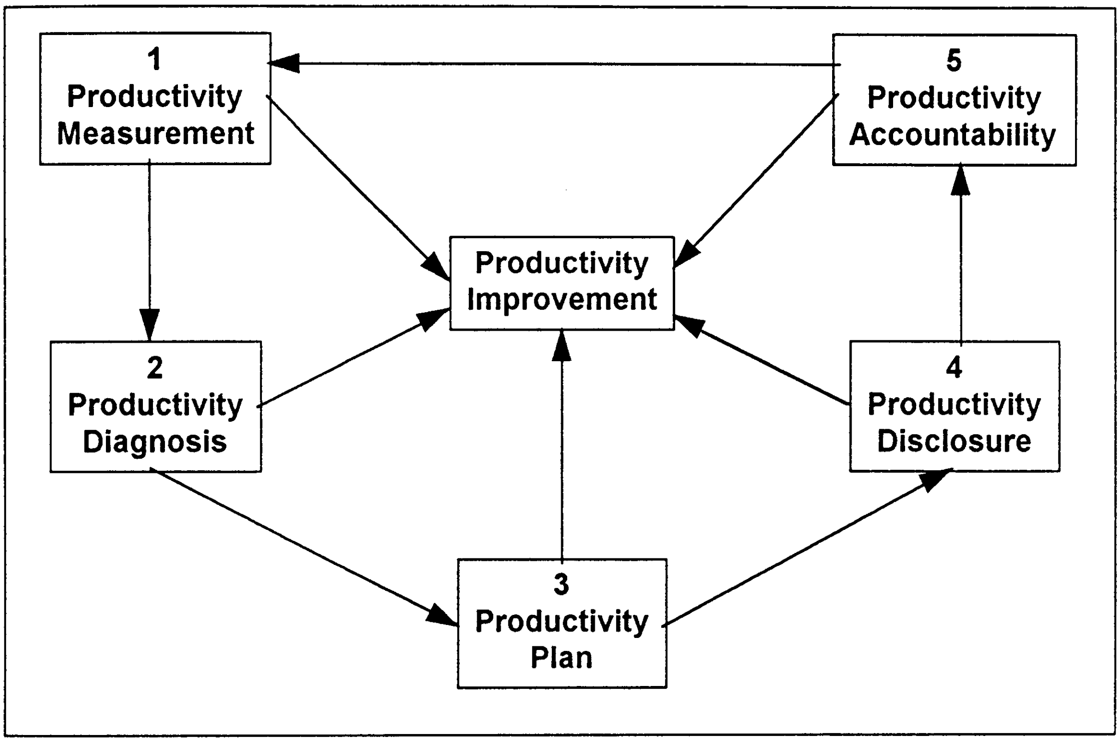

Figure C.5: The productivity management process (De Wit and Hamersma, 1992, p 204)

9.1. Productivity management process

9.1.1. Productivity measurement

During this stage productivity is measured in order to ascertain facts. Feedback signals are obtained from the measurement, and these can be used as a basis for decisions aimed at changing behaviour (De Wit and Hamersma, 1992, p 204).

9.1.2. Productivity diagnosis

This stage is aimed at identifying causes (De Wit and Hamersma, 1992, p 206).

9.1.3. Productivity plan

This stage comprises hard and soft components. The hard components consist of quantitative productivity targets. The soft components require that productivity improvement plans should be supported by written definitions of objectives, strategies and tactics needed for the improvements (De Wit and Hamersma, 1992, p 206).

9.1.4. Productivity disclosure

This stage includes the disclosure of performance to various audiences (De Wit and Hamersma, 1992, p 207).

9.1.5. Productivity accountability

During this stage management and labour assume joint accountability for productivity. It further requires that they should share in the benefit of any improvement in productivity (De Wit and Hamersma, 1992, p 207).

McAfee and Poffenberg (1983, p 143) propose a process to implement a goal oriented productivity improvement strategy. This process incorporates the following steps:

1. Set Organizational Goals
2. Set Area Goals
3. Set Individual Job Goals
4. Employees Formulate Objectives
5. Employees Formulate Plans
6. Employees Implement Plans
7. Evaluate if objectives were met
8. Determine reasons
9. Take corrective action

The foregoing discussion set a background on productivity, the objective of measurement, some available tools and the implementation of these tools. The rest of this review deliberates the Objectives Matrix as a measurement tool for service organizations.

10. Objectives matrix

The Objectives Matrix is the logical conclusion of many years of work by several people. None of the concepts utilized are new, but the combined use of all these concepts have led to the formulation of this new approach to performance measurement and improvement (Maartens, 1985, p 14). The main concept of the approach however was taken from the Management by Objectives approach (MBO). The MBO approach is deliberated in brief.

10.1. Management by Objectives (MBO)

The MBO approach developed from the "Traditional Objective Setting" approach. The central theme of this approach is that objectives are set at the top and then broken down into sub-goals for each level of the organization. The top imposes its standards on everyone below. This traditional perspective assumes that only top management know what's best, because only they can see the "big picture" (Robbins, 1988, p 140). The result of this approach is that objectives lose clarity and unity as they make their way down from the top (Figure C.6).

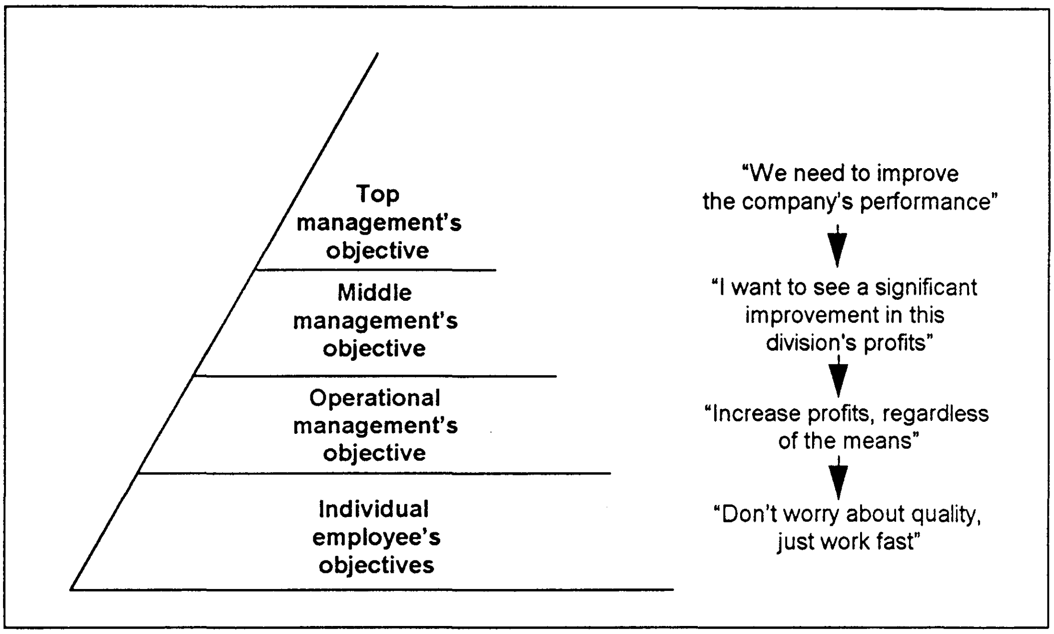

Figure C.6: The traditional objective setting.

An alternative approach to the traditional approach is Management by Objectives (MBO). It emphasizes participatively set goals that are tangible, verifiable, and measurable. Rather than using goals to control, MBO uses goals to motivate (Robbins, 1988, p 142). MBO's appeal lies in its emphasis on converting overall organizational objectives into specific objectives for organizational units and individual members. MBO operationalizes the concept of objectives by devising a process by which objectives cascade down through the organization. The organization's overall objectives are translated into specific objectives for each succeeding level in the organization (Figure C.7).

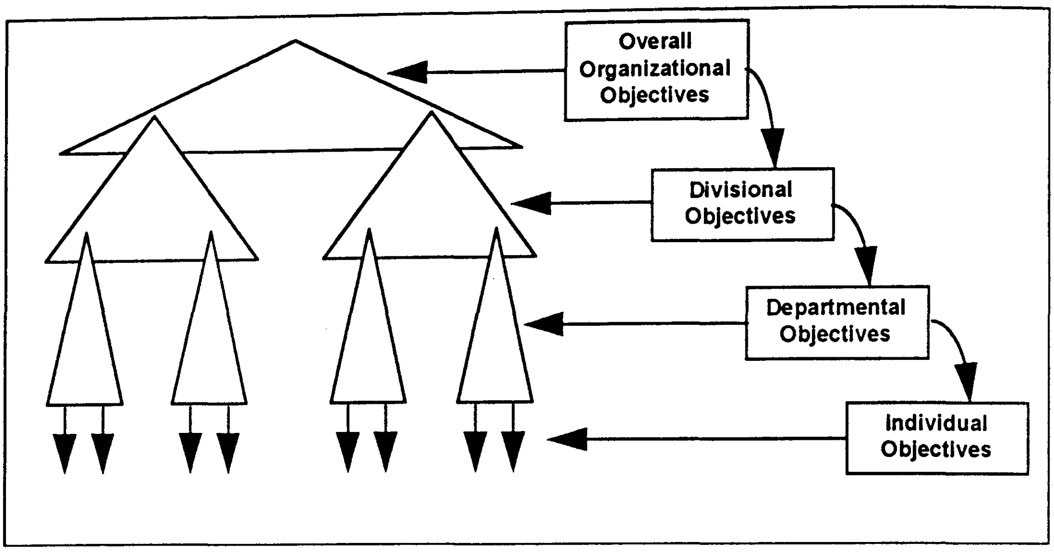

Figure C.7: Cascading of Objectives (Robbins, 1988, p 142)

The fact that lower unit managers jointly participate in setting their own goals, causes that MBO works from the "bottom up" as well as the "top down". The result is a hierarchy of objectives that link objectives at one level to those at the next level (Robbins, 1988, p 142).

There are four ingredients common to MBO programs, namely, goal specificity, participative decision making, an explicit time period, and performance feedback (Robbins, 1988, p 142).

Having discussed the foundation of the Objectives Matrix, the Objectives Matrix *per se* is deliberated next.

10.2. Objectives matrix

The President's Council (1989, p 22) suggests the use of the Objectives Matrix for performance measurement in service organisations.

The Objective Matrix is a logical and effective method for measuring and improving performance (Maartens, 1985, p 14). The Matrix is relatively easy and cheap to develop and can be used for almost all types of work. It utilizes different performance attributes to measure the performance of individuals, functional groups, departments and organizations. The criteria depicting these attributes are collected in a matrix format that establishes a scoring system for rating each performance criterion. A weighting system indicates the relative importance of all criteria, as well as a procedure for determining an overall index of performance progress. By these means the Objectives Matrix awards credit to those who earn it, and shows where improvement is needed most when performance falls below expectation.

Maartens (1985, p 15) states that the Objectives Matrix is a useful tool to help management to plan, organise and control the resources of the organization, and in the process involve the workers concerned thus improving motivation and communication. If the process is tackled in the right way it can be conducive to a better working relationship between management and the workers. The workers will have a better idea of what management expects from them, and management can help the workers to try and attain higher goals, concentrate on strengths and minimise weaknesses (Maartens, 1985, p 15).

The Objectives Matrix is further discussed under the headings: [1] Advantages of the Objectives Matrix; and [2] Development and Implementation of the Objectives Matrix.

10.2.1. Advantages of the Objectives Matrix

According to Van Aardt (1990, p 3) and Hartshorne (1989, p 90) the Objectives Matrix has the following advantages as a measuring tool:

1. The total performance of an organization can be measured, and can be described as a single number.
2. The Objectives Matrix provides a measuring tool to measure performance in a multi-disciplinary organization.
3. Performance can be measured at any organizational level.
4. Existing measurement systems can be incorporated in an Objectives Matrix.
5. It is relatively easy and cheap to develop and maintain.
6. If developed correctly the Objectives Matrix is accepted without resistance by workers.
7. It is a useful tool in performance improvement.
8. It identifies problem areas.

10.2.2. Development and implementation of the Objectives Matrix

The development and implementation of the Objectives Matrix are discussed from Geyser (1986, p 6-17) and Van Aardt (1990, p 4-13). The development and implementation of the Objectives Matrix can be described as a 5 step process, namely: [1] Management planning and training, [2] Staff commitment and training, [3] Development of Matrix, [4] Performance measurement, and [5] Evaluation (Figure C.8). These steps are deliberated in more detail.

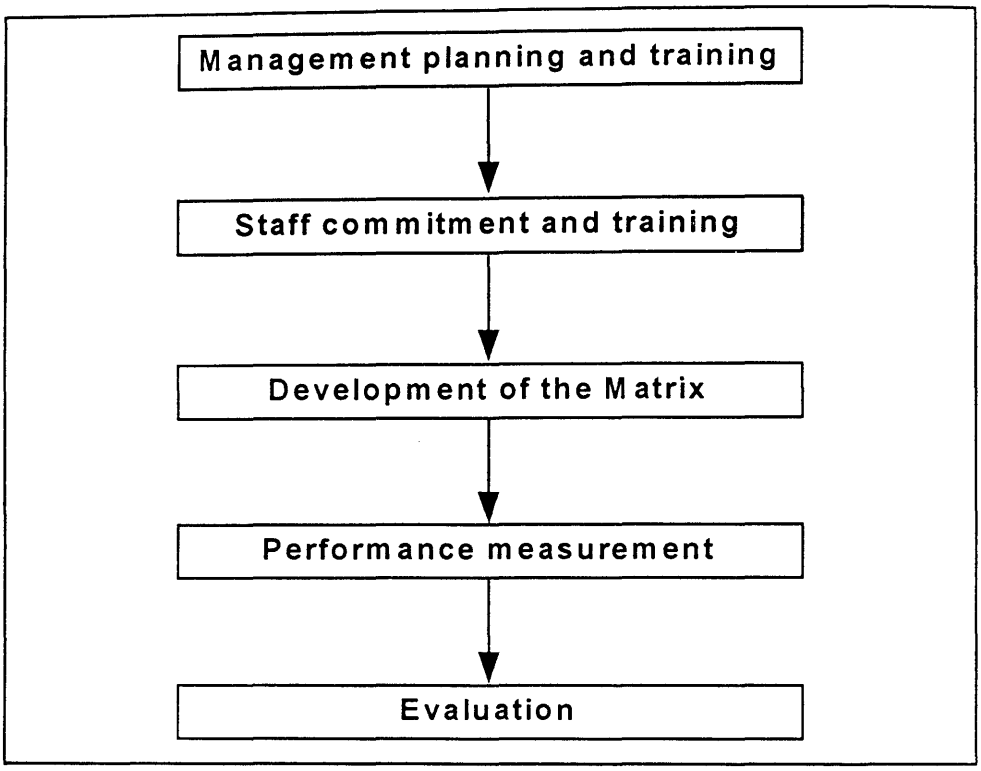

Figure C.8: Development process of the Objectives Matrix

10.2.2.1. Management planning and training

The management planning and training phase consists of four modules:

10.2.2.1.1. Definition of the points of departure

During this phase management should formalise the reasons why they want to improve productivity and what they want to achieve with the programme.

10.2.2.1.2. Exposure to productivity concepts and measurement techniques

The following elements should be incorporated in this module:

- The productivity dilemma of South Africa and a broad perspective of the organization's productivity position.
- Productivity concepts.
- How to define outputs, inputs and productivity ratios.
- The relationship between profits, productivity and price recovery.

- How to identify and define the key factors which influence productivity.

10.2.2.1.3. Exposure to supporting techniques

Depending on the circumstances in the organization it might be required to expose the management team to certain techniques such as:

- Elements of planning.
- Management of change.
- Organizational diagnostic survey.
- Problem solving.
- Decision making and goal setting.
- Motivation.
- Communication.
- Nominal group technique.

10.2.2.1.4. Decisions on the structure of the improvement programme

The following elements should be incorporated in this programme:

- Why productivity programmes fail.
- Characteristics of successful programmes.
- The role of the employee in the programme.
- The role of management in the programme.

The role of management covers a number of important points:

- Decide on the delegation and allocation of responsibility.
- Give careful consideration to the financial benefits of the programme and the necessary resources.
- Finalise how the programme will be announced, and how an awareness of and commitment to the programme will be created.
- Agree on the way in which participation and involvement of the staff will be obtained.
- Decide on guideline productivity targets.

10.2.2.2. Staff commitment and training

During this phase management is attending to the very important aspect of staff commitment and training. This phase also consists of four modules:

10.2.2.2.1. Announcement of the programme

This module covers the following aspects:

- Issuing a policy statement.
- Discussing with the staff the company's productivity position and overall goals of the programme.
- Spelling out the benefits of the programme to the organization and to the staff.
- Outlining to the staff the nature of the training they could expect to receive.
- Giving a detailed outline of how the programme will be structured.
- Inviting the staff to identify improvement opportunities and to participate in the programme.

10.2.2.2.2. Training of staff in productivity concepts and measurement techniques

This phase is to some extent the same as that of management training, except that the training offered in this module is specifically directed at the staff's needs.

10.2.2.2.3. Training of staff in supporting techniques

The following issues should receive attention: [1] How to handle change; [2] Problem solving; [3] Group interaction; and [4] Communication.

10.2.2.2.4. Work-related training

It might be necessary to evaluate and modify the organization's approach to training in order to match the productivity standards.

10.2.2.3. Development of the Objectives Matrix

The Objectives Matrix should always be developed with the full co-operation of the concerned employees. The development of the Objectives Matrix includes the following steps, which should be followed during group discussions:

10.2.2.3.1. Identification of Key Performance Areas (KPA)

Key performance areas are those aspects of a service which vastly contribute to the delivery of an acceptable service. There are two important issues concerning KPA's:

- A key performance area cannot be used if the employees do not have any control or influence on it.

- Key performance areas should always contribute to the goal and mission of the organization.

10.2.2.3.2. Develop criteria to measure performance in KPA's

Criteria are needed to measure performance on a quantitative scale. It is normally in the form of a ratio. The criteria should adhere to the following requirements:

- It should measure what it is supposed to measure.
- It should not be too complicated.
- It should be economical (should not use a lot of time or energy).
- It should use available information if possible.

10.2.2.3.3. Determine performance scales

Performance scales are determined to measure any change in performance. These scales are developed by:

- Determining the current level of performance (Level 3).
- Determining the realistic goal (Level 10).
- Determining the minimum acceptable level (Level 0).
- Calculating the eleven point performance scale (From level 0 to 3 and from level 3 to 10).

10.2.2.3.4. Determine relative weights of criteria

Relative weight values are allocated to the criteria in order to establish the difference in importance between the different criteria. The total value of the weights is normally 100.

10.2.2.3.5. Composition of the Objectives Matrix

The final Objectives Matrix is composed from the information in the preceding steps. See example of an Objectives Matrix in Appendix O.

10.2.2.4. Performance measurement

Personnel should measure their own performance on a regular interval.

10.2.2.5. Evaluation

During this phase the performance is evaluated against a norm and/or other individual's/department's performance and/or performance in the past.

10.2.3. Problems to consider

Two problems as far as employees are concerned need attention when the introduction of the Objectives Matrix is considered, namely: [1] People's fear of being measured; and [2] People's innate fear of change. These fears have to be addressed satisfactorily before the Objectives Matrix can be introduced successfully into an organization. The reason why people fear measurement and the management of change are deliberated briefly in the following section.

10.2.3.1. Why productivity measurement is a threat

Employees and managers whose performance are being measured have a number of potential sources of concern or fear, namely (Tuttle and Sink, 1985, p 31):

- ⇨ The potential misunderstanding and misuse of information by higher management.
- ⇨ The fear of exposing inadequate performance.
- ⇨ The fear of additional paperwork and additional reporting burdens.
- ⇨ The fear of reduction in staff.
- ⇨ The fear of distorting performance priorities.
- ⇨ The fear of a loss of autonomy.
- ⇨ The fear of the introduction of tighter management controls.

10.2.3.2. Managing change

Implementing a productivity measurement system is an organizational change. Change leads to resistance that seeks to maintain the status quo. Therefore, managing the introduction of a productivity measurement system involves managing resistance to change. Stoner and Freeman (1992, p 408) defines planned change as the systematic attempt to redesign an organization in a way that will help it adapt to changes in the external environment or to achieve new goals.

A useful technique for helping managers understand the change process is force field analysis developed by Kurt Lewin (Stoner and Freeman, 1992, p 410). The force field analysis is a process of analyzing the forces for (driving) and against (restraining) a change in behaviour by an individual or a group. The force field analysis consists of the following four-step process (Tuttle and Sink, 1985, p 31):

1. Define the desired outcome.

2. Generate the driving and restraining forces working for and against achieving the desired outcome. (Figure C.9 illustrates a possible force field analysis)
3. Select the most important driving and restraining forces.
4. Develop plan to increase driving forces and decrease restraining forces.

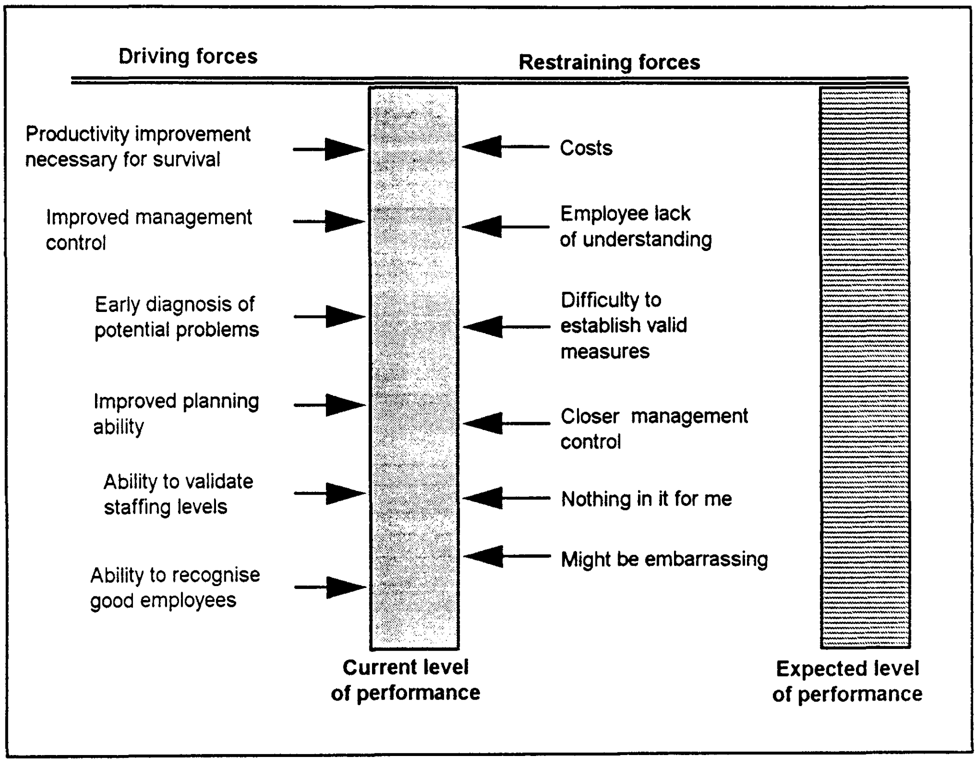

Figure C.9: Force-field analysis for a productivity measurement implementation.

The natural tendency, if we want change, is to push. The equally natural tendency of whomever or whatever is being pushed, is to push back - driving forces create their own restraining forces (Stoner and Freeman, 1992, p 410). Decreasing the restraining forces is therefore normally a more effective way to encourage change than increasing the driving forces. According to Tuttle and Sink (1985, p 32) many of the restraining forces in Figure C.9 can be defused or avoided by involving managers and employees of the units to be measured in the development process. This involvement will build a sense of ownership and change the perception of the measurement process from that of management's system to "our" system. This change in perceptions cannot be created overnight, but this participation coupled with a participative planning process, shared business information, and accountability can be very effective.

Increasing the driving forces can positively be applied in at least three ways (Tuttle and Sink, 1985, p 32):

> The first implementation strategy to increase the positive forces is to simply share previously undisclosed business information. The purpose of this information sharing is to create a sense of trust, to educate subordinates to economic realities, and to subtly suggest that survival of the organization and continued job security depend on maintaining competitiveness.
>
> A second strategy is to develop and communicate a collective vision of the organization's purpose, philosophy and values.
>
> A third strategy is developed through top management leadership. Through their behaviour and words top management must communicate the message that productivity is important and explain why. It is necessary to make middle level managers accountable, or they will not think the effort is serious. In a carrot and stick approach, this accountability is the stick (Tuttle and Sink, 1985, p 32)

11. Summary

From this review of the literature we can conclude that although productivity analysis in health care is a relatively underdeveloped management tool, there are techniques and tools available from other disciplines that can help the health manager measure health care performance. It is finally indicated that the Objectives matrix is an effective performance measurement and improvement tool, if implemented correctly.

APPENDIX D

DMFT/dmft and DMFS/dmfs INDEXES

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APPENDIX D

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DMFT/dmft and DMFS/dmfs INDEXES

1. General information

The DMFT/dmft and DMFS/dmfs indexes were used, with minor adjustments as proposed by the WHO (1987, p 34-37). For the DMFS/dmfs indexes the same criteria and codes were used as for the DMFT/dmft indexes. With the DMFS/dmfs each tooth is divided into five surfaces namely, occlusal; mesial; distal; buccal and lingual/palatal. Each surface is evaluated separately in order to describe the geographical distribution of caries within the mouth.

The diagnosis of caries is based upon visual identification after the removal of debris and moisture. A probe is used to:

a. Confirm visual identification

b. Help with diagnosis of caries in the inter proximal areas of posterior teeth.

The probe should be "blunt" with a diameter of 0,4 mm. The mechanical power applied to diagnose dental caries should be enough to penetrate a rubber for 2-3 mm.

2. Codes for caries status

A *numerical* coding system is used for recording the status of permanent teeth and an *alphabetical* coding system for primary teeth. On the survey form the same boxes are used for both the primary and permanent teeth. A distinction is made solely by use of alphabetical or numerical codings. An entry must be made in every box on the chart. Codes for the dental caries of primary and permanent teeth are as presented in Table D.1.

Permanent tooth code	Condition/ Status	Primary tooth code
0	Sound	A
1	Decayed	B
2	Filled, with decay	C
3	Filled, no decay	D
4	Missing, due to caries	E
5	Missing, due to other reason	-
6	Sealant, varnish	F
7	Bridge abutment or special crown	G
8	Unerupted tooth	-
9	Excluded tooth	-

Table D.1: Codes for dental caries of primary and permanent teeth according to the DMFT Index

APPENDIX D

3. Criteria for diagnosis and coding (primary tooth codes in parentheses) :

0 (A) - *Sound tooth*

A tooth is recorded as sound if it shows no evidence of treated or untreated clinical caries. The stages of caries that precede cavitation, as well as other conditions similar to the early stages of caries, are excluded because they cannot be reliably diagnosed. Thus, teeth with the following defects, in the absence of other positive criteria, should be recorded as sound:

- white or chalky spots
- discoloured or rough spots
- stained pits or fissures in the enamel that catch the explorer but do not have a detectably softened floor, or softening of the walls
- dark, shiny, hard, pitted areas of enamel in a tooth showing signs of moderate to severe fluorosis

All questionable lesions should be coded as sound.

1 (B) - *Decayed tooth*

Caries is recorded as present when a lesion in a pit or fissure, or on a smooth tooth surface, has a detectable softened floor, undermined enamel or softened wall. A tooth with a temporary filling should also be included in this category. On approximal surfaces, the examiner must be certain that the explorer has entered a lesion. Where any doubt exists, caries should not be recorded as present.

2 (C) - *Filled tooth with decay*

A tooth is scored as filled with decay when it contains one or more permanent restorations **and** one or more areas that are decayed. No distinction is made between primary and secondary caries (i.e. whether or not the carious lesions are in physical association with the restoration(s)).

3 (D) - *Filled tooth with no decay*

Teeth are considered filled without decay when one or more permanent restorations are present and there is no secondary (recurrent) caries or other area of the tooth with primary caries. A tooth with a crown placed because of previous decay is recorded in this category. A tooth that has been crowned for reasons other than decay, e.g., trauma or as a bridge abutment, is recorded as "bridge abutment or special crown" and coded 7 (G).

4 (E) - *Tooth missing due to caries* This score is used for permanent or primary teeth that have been extracted because of caries. For missing primary teeth, this score should be used only if the subject is at an age when normal exfoliation would not be a sufficient explanation for absence.

In some age groups, it may be difficult to distinguish between unerupted teeth and extracted teeth. The following can help in making the decision:

- basic knowledge of tooth eruption patterns
- status of corresponding contra lateral tooth
- the appearance of the alveolar ridge in the area of the tooth space in question
- caries status of other teeth in the mouth

It is emphasized that code 4 should not be used for teeth judged to be missing for any other reason than caries.

5 (-) - *Permanent tooth missing for any other reason* This code is used for permanent teeth judged to be absent congenitally, or extracted for orthodontic reasons or because of trauma, etc. This score is also used for permanent teeth that are judged to have been extracted because of periodontal disease.

6 (F) - *Sealant* This code is used for teeth in which a fissure sealant has been placed on the occlusal surface; or for teeth in which the occlusal fissure has been enlarged with a bur, and a composite material placed. If a tooth with a sealant is decayed, it should be coded as 1 (decayed).

7 (G) - *Bridge abutment or special crown* This code is used to indicate that a tooth forms part of a fixed bridge, i.e., is a bridge abutment. This code can also be used for crowns placed for reasons other than caries. *Note:* Missing teeth replaced by a bridge are coded 4 or 5, as for other missing teeth.

8 (-) - *Unerupted teeth* This classification is restricted to permanent teeth and used only for a tooth space with an unerupted permanent tooth but without a primary tooth. Teeth scored as unerupted are, of course, excluded from all calculations concerning dental caries. For differential diagnosis between extracted and unerupted teeth, see code 4.

9 (-) - *Excluded teeth* This code is used for any tooth that cannot be examined.

4. DMFT and dmft indexes

Information on the Decayed, Missing and Filled Teeth Index (DMFT) can be calculated from the information as coded above. The D-component includes all teeth with codes 1(or B) or 2(or C). The M-component comprises teeth with code 4(or E) in subjects under 30 years of age, and teeth coded 4 and 5 for subjects 30 years and older, i.e., missing due to caries or for any other reason. Previously only teeth missing due to caries were included in the DMFT index and in its M-component. The F-component includes only teeth with code 3(or D). The basis for DMFT calculations is 32, i.e., all permanent teeth including wisdom teeth. Teeth with codes 6 and 7 are not included in the DMFT.

APPENDIX E

TREATMENT NEEDS

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TREATMENT NEEDS

1. Treatment requirements of individual teeth

Treatment requirements of individual teeth were determined according to the criteria proposed by the WHO (1987, p 37-39) with minor adjustments.

Immediately after the caries status of a tooth is recorded, and before proceeding to the next tooth space, the type of treatment required, if any, should be recorded. If no treatment is required, score "0" in the appropriate treatment box. The codes for treatment needs are:

Treatment need code	Condition / Treatment need
0	Sound tooth - No treatment
F	Sound tooth - Fissure sealant needed
T	Questionable tooth -Therapeutic-preventive treatment
H	Enamel caries - Preventive Resin Restoration
1	One surface filling
2	Two surface filling
3	Three surface filling
4	Four or more surface filling
5	Extraction due to caries
6	Extraction due to other reason
7	Other treatment needed

The criteria for treatment needs are:

0 - *No treatment* — This code is recorded if a tooth is sound or if it is decided that a tooth cannot or should nor be extracted or receive any other treatment.

F - *Fissure sealant* — This code is recorded when a tooth is sound and need a fissure sealant according to the criteria in Appendix F.

T - *Therapeutic Preventive Treatment* This code is recorded when a tooth has questionable enamel caries and a fissure sealant will be used to seal the questionable pits or fissures, according to the criteria in Appendix F.

H - *Preventive resin restoration (PRR)* This code is recorded when a tooth has minimal enamel caries. The caries should be removed with a round bur and a fissure sealant is used to "restore" the tooth, according to the criteria in Appendix F.

1,2,3,4 - *One, two, three, four or more surface restoration* One of these codes should be used to indicate the treatment required to: treat initial, primary or secondary caries; repair damage due to trauma; treat discoloration of a tooth, a pulpal condition, or a developmental defect; or replace unsatisfactory fillings.

A filling is considered unsatisfactory if one or more of the following conditions exist:
- a **deficient margin** to an existing restoration that has leaked or is likely to permit leakage into the dentine. The decision as to whether or not a margin is deficient should be based on the examiner's clinical judgment, on evidence gained from the insertion of an explorer at the margin, or on the presence of severe staining of the tooth structure.
- an **overhanging margin** of an existing restoration that causes obvious local irritation to the gingivae and cannot be removed by re-contouring of the restoration
- a **fracture of an existing restoration** that either causes it to be loose or permits leakage into the dentine.

5 - *Extraction due to caries* A tooth is recorded as 5 when: caries has so destroyed the crown that it cannot be restored; caries has progressed to such an extent that there is an obvious and open exposure of the pulp and the restoration of the tooth is not possible; only the roots of the tooth remain.

6 - *Extraction due to other reasons* A tooth is recorded as 6 when: periodontal disease has progressed so far that the tooth is loose or functionless and, in the clinical judgment of the examiner, cannot be restored to a firm and functional state by periodontal therapy; a tooth needs to be extracted to make way for a prosthesis; or extraction is required for orthodontic or cosmetic reasons, or because of impaction.

Note: One tooth may be indicated for extraction due to more than one reason. The examiner should try to establish the primary cause for extraction. This code should be recorded.

7 - *Other treatment needed* This code indicates treatment that is not indicated above.

APPENDIX E

APPENDIX F

CRITERIA FOR FISSURE SEALANTS, PREVENTIVE THERAPEUTIC SEALANTS AND PREVENTIVE RESIN RESTORATIONS

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APPENDIX F

CRITERIA FOR FISSURE SEALANTS, PREVENTIVE THERAPEUTIC SEALANTS AND PREVENTIVE RESIN RESTORATIONS

1. Criteria for conventional fissure sealants

Treatment needs for fissure sealants were established by criteria compiled by the Department of Community Dentistry, Dental Faculty, University of Pretoria (Table F.1).

<table>
<tr><th>Clinical consideration</th><th colspan="2">Seal</th><th>Do not seal</th></tr>
<tr><td>Occlusal morphology</td><td colspan="2">Deep, narrow pits and fissures</td><td>Broad, well-coalesced pits and fissures</td></tr>
<tr><td>Tooth Age</td><td colspan="2">Recently erupted tooth</td><td>Teeth caries free for four years or longer</td></tr>
<tr><td>Caries activity</td><td colspan="2">Many occlusal lesions or restorations, and few proximal lesions or restorations on other teeth</td><td>Caries free, or
Many proximal lesions</td></tr>
<tr><th colspan="2">Permanent teeth</th><th colspan="2">Primary teeth</th></tr>
<tr><td colspan="2">Seal remaining sound molars if a first molar is already occlusally carious or restored
Seal first molars if high caries prevalence in primary dentition
Seal second molars if first molars are already occlusally carious or restored</td><td colspan="2">Seal remaining molars if one molar is already occlusally carious or restored</td></tr>
</table>

Table F.1: Criteria to establish the fissure sealant treatment need in children.

These criteria should be seen as a whole when a decision is made. Rather seal too much.

The illustration in Figure F.1 was used in the field to ensure understanding and consistency.

APPENDIX F

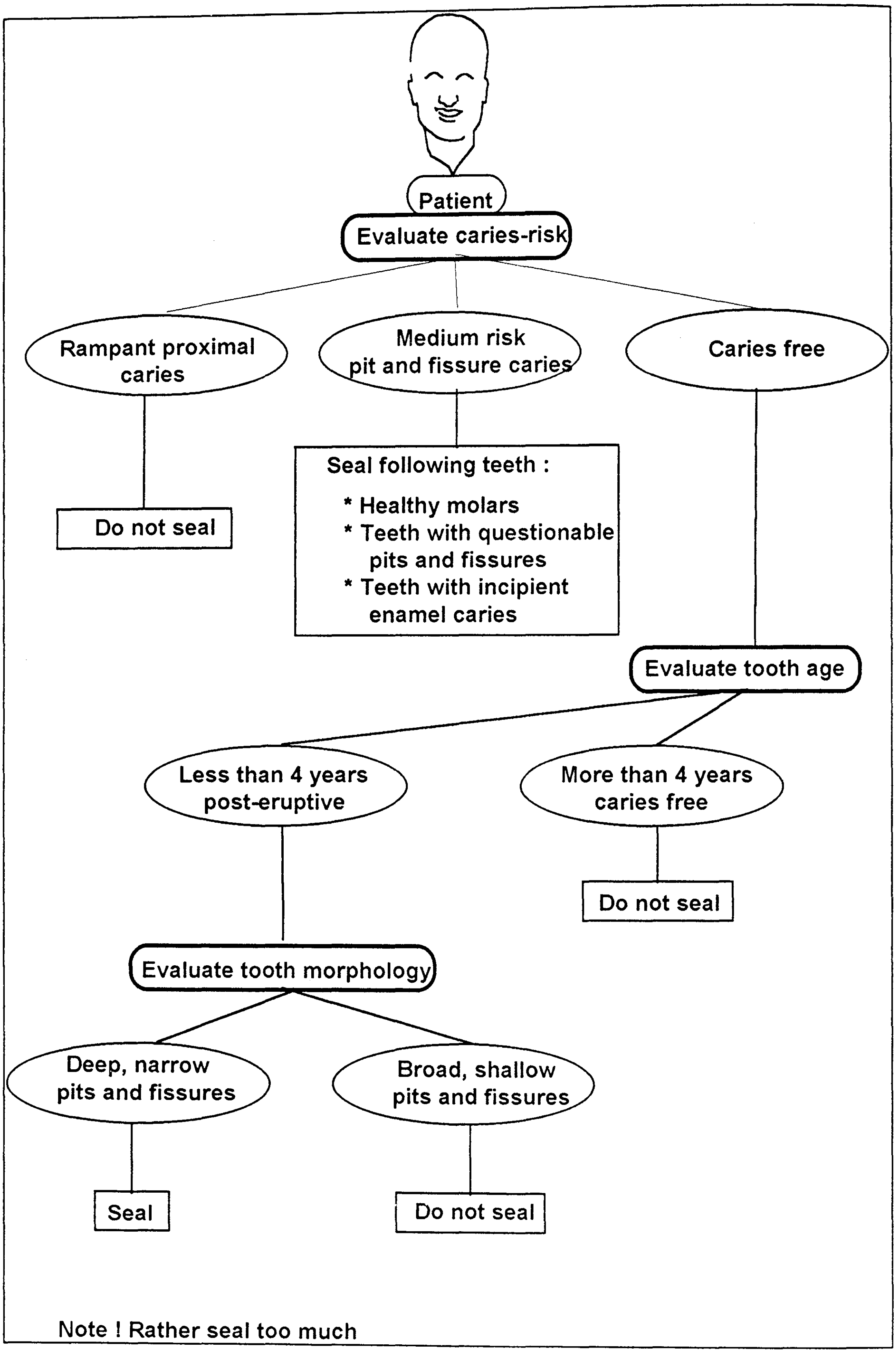

Figure F.1: A diagram to select teeth for pit and fissure sealants

2. Criteria for therapeutic preventive treatment

This treatment should be followed under the following circumstances:

- Teeth with active, early pit and fissure caries
- Teeth with early pit and fissure caries where the activity of the disease is uncertain
- Teeth with uncertain caries

3. Criteria for Preventive Resin Restoration

This treatment should be followed under the following circumstances:

- Active occlusal caries
- There is no undermining of the enamel
- There is no dentine involvement

APPENDIX F

APPENDIX G

SURVEY FORM

APPENDIX G

APPENDIX G

SUID AFRIKAANSE GENEESKUNDIGE DIENS

KARIESONDERVINDING EN BEHANDELINGSBEHOEFTE BY LAERSKOOLKINDERS

Kaart no 1 [ ] Registrasie no 2 [| | |] 5 Ondersoeker 6 [|] 7

Ondersoekpunt 8 [|] 9 Duplisering 10 [ ] Nee = 0 Ja = 1

	M	M	J	J			M	M	J	J	
Datum van ondersoek 11					14	15					18
19					22	23					26
27					30	31					34

PERSOONLIKE BESONDERHEDE VAN KIND

NAAM: Van: ______________________ Noemnaam: ______________ Voorletters:

	D	D	M	M	J	J	
Geboorte Datum 35							40

Geslag 41 [ ] Manlik = 1 Vroulik = 2

Geboorte Volgorde 42 [ ]

BESONDERHEDE VAN OUERS/VOOGDE

Broodwinner 43 [ ] Vader = 1 Moeder= 2 Ander = 3 Rang______ 44 [|] 45 Magsdeel 46 [ ]

Magsno 47 [| | | | | | |] 54 55 [|] 56

Eenheid__________________ 57 [| |] 59 Taal 60 [ ]

Afrikaans = 1
Engels = 2
Oorw/afr = 3
Oorw/eng = 4
Afr/Eng = 5
Ander = 6

Beroep(B)_________________ 61 [|] 62

Beroep(G)_________________ 63 [|] 64 Huwelikstatus 65 [ ]

Getroud = 1
Ongetr = 2
Weduwee = 3
Ander = 4

Aantal kinders 66 [|] 67

APPENDIX G

Krt no			TND	STA	O	M	B	D	L	B/B	FIS	EVL	EVL	EVL	EVL	EVL	EVL	EVL	EVL	
1	6		17																	21
	22	M	16																	37
	38	A	15																	53
	54	K	14																	69
1	6	S	13																	20
	21	I	12																	35
	36	L	11																	50
	51	L	21																	65
1	6	A	22																	20
	21		23																	35
	36		24																	51
	52		25																	67
1	6		26																	21
	22		27																	37

Krt no			TND	STA	O	M	B	D	L	B/B	FIS	EVL	EVL	EVL	EVL	EVL	EVL	EVL	EVL	
	38		37																	53
	54	M	36																	69
1	6	A	35																	21
	22	N	34																	37
	38	D	33																	52
	53	I	32																	67
1	6	B	31																	20
	21	U	41																	35
	36	L	42																	50
	51	A	43																	65
1	6		44																	21
	22		45																	37
	38		46																	53
	54		47																	69

APPENDIX H

CRITERIA FOR THE EVALUATION OF FISSURE SEALANTS

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APPENDIX H

APPENDIX H

CRITERIA FOR THE EVALUATION OF FISSURE SEALANTS

1. Evaluation criteria

Fissure sealants placed were evaluated in follow-up years. The codes and criteria in Table H.1 were used.

Evaluation Code	Condition/Status
W	Fissure sealant completely intact, and tooth healthy
P	Fissure sealant partially lost, and tooth healthy
L	Fissure sealant completely lost, and tooth healthy
K	Tooth carious or restored
I	Fissure sealant intact, and tooth interproximaly carious
V	Tooth crowned or extracted

Table H.1: Evaluation criteria for fissure sealants.

APPENDIX H

APPENDIX I

JOB DESCRIPTION FOR DENTISTS AND FIELD TEAM LEADERS

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APPENDIX I

APPENDIX I

JOB DESCRIPTION FOR DENTISTS AND FIELD TEAM LEADERS

JOB DESCRIPTION: TEAM MEMBERS AND TEAM CO-ORDINATORS

NAME: ________________________________

FORCE NUMBER: ____________________________

DATE: ______________________________________

As a team member of the first combined Epidemiological and Preventive programme, your duties and responsibilities include the following:

1. To always strive to achieve the goals of the project - in this way contributing to its eventual success.
2. To make certain that the project is concluded on schedule.
3. To always act professionally, ethically and in a clinically correct way.
4. To be in charge of the people working under you.
5. To make a contribution towards the training and development of the oral hygiene students.
6. To ensure that the quota-books of the students are signed off correctly and consistently.
7. To make sure that the instruments are sterilised as prescribed.
8. To see to it that all forms are completed accurately.
9. To see to it that all the forms are collected.

10. To make certain that the names of the children who are being referred to dental clinics are indicated on the class-lists.

11. To identify high risk children and indicate their names on the class-lists. (A high risk child is one who has two or more carious lesions/renovations on smooth surfaces.)

12. To pay attention to the upkeep and maintenance of the instruments and equipment.

13. To give full co-operation to your team co-ordinator.

14. To make a positive contribution towards the morale of the team members.

15. To note and hand-over to the co-ordinator at the end of the project any aspects regarding:

    - the continuous planning of the project,
    - improved plans for future projects,
    - the implementation of the project as such,
    - evaluation on completion of the project,
    - any observations or aspects which may effect the analysis and interpreting of the data.

SPECIFIC TASKS OF THE TEAM CO-ORDINATOR:

You are responsible for your team. In addition to the above-mentioned duties, you have the following responsibilities:

1. To contact the principal and keep him informed about the programme.

2. To obtain the class-lists of our target-group.

   TARGET-GROUP: SADF schoolchildren
   - Grade 1 & 2
   - Std 1, 4 & 5

   (Class-lists will be discussed with the principals beforehand.)

3. To assign registration numbers to the children on the class-lists in accordance with the assigned series numbers for each school.

4. To be responsible for all instruments, materials and equipment issued to your team.

a) EQUIPMENT:

Mobile chair	x	1
Mobile unit	x	1
Compressor	x	1
Mobile light	x	1
UV light	x	1
Mobile suction cup	x	1
Slow handpiece	x	1
Motor for the above	x	1

b) INSTRUMENTS:

Mirrors	x	20
Probes	x	20
Pincettes	x	2
Sterilisation bowls	x	2
Clipboards	x	2
Sharpeners	x	2

5. To make certain that all instruments, materials and equipment are safely locked up and stored after working hours.

6. To see to it that every child whose name appears on the class-list is examined.

7. To see to it that every 10th (tenth) child is examined twice.

   - Both forms have the same registration number
   - The two forms are kept together (paperclip)
   - Correlate the reliability and signify approval if necessary

8. To revise the forms obtained from a survey on a particular day on the same day for the sake of completeness.

9. To ensure that all forms are kept in a safe place and handed over to the project co-ordinater together with the class-lists of the school.

10. To see to it that all instruments, materials and equipment are packed thoroughly for transportation at the end of each school session.

11. To see to it that instruments, materials and equipment are unpacked and put up at the next school.

12. To control consumable stock and request new supplies in good time.

13. To request teachers to help fill in the forms.

DECLARATION:

I hereby declare that I understand the contents of the job description and that I shall keep to it.

Signed at _______________ on this _______ day of ____________________ 19____

NAME: _________________________ **SURVEY NUMBER:** __________

____
CONFIRMED AND RECEIVED

____
(Co-ordinator)

APPENDIX J

EQUIPMENT, INSTRUMENTS AND MATERIALS CONTROL FORM

APPENDIX J

Equipment, Instruments and Materials Control Form

Description :____________________ Package : ______________

Date	Issued to	Received from	Quantity	Total issued	Total received	Total Used

APPENDIX J

APPENDIX K

PREVENTIVE PROJECT DIARY

APPENDIX K

Preventive Project Diary

Date : ____________________

Team members: 1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________

School: ____________________
Principal: ____________________
Secretary: ____________________
Other: ____________________

1. Clinical Statistics

Group (Grade/Std)	Epi # Children	Prev # Children	High Risk # Children

2. Problems, Incidents, etc.

3. Notes (ideas for the future)

APPENDIX K

APPENDIX L

LETTER OF CONSENT

APPENDIX L

APPENDIX L

North Med Command
Rose St
Riviera
February 199?

Dear Parent

PREVENTATIVE DENTAL PROGRAMME : PTA SCHOOLS

The Dental section of SAMS is engaged in a preventative dental programme at certain schools in Pretoria.

The purpose of the programme is to promote the oral health of your child. The programme involves a general examination of the mouth in order to identify potential problems and the application of a sealant to protect the teeth from dental caries (cavities).

Would you please complete the blank spaces on the form below. We need the information for the follow-up programmes and also to identify your child on our databasis.

We believe that this special service provided to your child at school is of benefit.

Thank you for your co-operation.

____

(OFFICER COMMANDING NORTHERN MEDICAL COMMAND : BRIG)

I __________________________ hereby give my permission/ not permission for the dental examination and preventive treatment of my child _______________________ by the dental members of the SAMS.
(Scratch if not applicable)

Rank: _________ Force number: ________________ Unit: _____________

____

SIGNATURE

APPENDIX L

APPENDIX M

LETTER TO PARENTS CONCERNING ORAL HEALTH STATUS AND TREATMENT NEEDS OF CHILDREN

Northern Medical Command
Oral Health Service

Name of Child : ____________________________

Number : ________________________________

Dear : ______________________

Your child have been examined by a member the Oral Health Service of the SAMS on the ____________ 1990.

The following was observed:

Healthy mouth	☐
Gum disease	☐
Dental caries	☐
Alignment of teeth	☐
Other	☐

You are requested to ensure that your child receives the following dental treatment at a military dental clinic nearest to you. (Please take this letter with you).

Comprehensive examination	☐
Oral hygiene instructions	☐
Scale and polish	☐
Preventive treatment	☐
Restorations	☐
Orthodontics	☐
Other	☐

With thanks.

____
(OFFICERS COMMANDING NORTHERN MEDICAL COMMAND : BRIG)

____
pp Dental Team

APPENDIX M

APPENDIX N

PRODUCTIVITY AWARD

APPENDIX N

APPENDIX N

1 · 9 · 9 · 3

NATIONAL · PRODUCTIVITY · AWARD

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Chairman Voorsitter

APPENDIX N

APPENDIX O

OBJECTIVES MATRIX

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APPENDIX O

APPENDIX O

OBJECTIVES MATRIX

Name : ______________________ Date : ______________________

Clinic : ______________________ Cmdmt ______________________

KP-Areas: Caries-prevention (1–2); Perio prevent (3–4); Curative Treatment (5–9); Patient priority (10); Treat prior (11); Quality (12–15); Manpower Utilization (16); Infra-structure (17)

Performance Criteria

1. OHI & Prophylaxes/Child Visits
2. Fissure sealants/Post Rest on Child
3. OHI & Prophylaxes/Adult Visits
4. Plastic Rest/Total Visits
5. Plastic Restorl/Prostic Replacement
6. Number Extractions/Total Visits
7. Emergency Root/Completed Root
8. Remove Prosthesis/Fixed Prostheds
9. Number active member/Total Visits
10. Preventive Visits/Treatment Visits
11. Patients Completed/Total Visits
12. Emergency Visits/Total Visits
13. Restorations Replaced/Total Restorations
14. Temporary Rest/Total Restorations
15. Monthly Turnover/R30 000
16. Number Referals/Total Visits
17. Turnover Clinic*1,5/Number Surgeries*Turnover Individual

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Performance																	
10 Objective	70	400	80	15	100	0.0	50	100	60	200	70	10	5	0	100	0.0	1.0
9	64	344	71	17	88	0.6	65	88.5	58	177	65	13	10	3	92	0.1	1.1
8	57	288	62	19	76	1.1	81	75	55	154	60	17	16	6	84	0.3	1.1
7	51	232	53	21	64	1.7	96	62.5	53	131	55	20	21	9	76	0.4	1.2
6	44	176	44	24	53	2.3	112	50	51	108	49	23	26	11	67	0.6	1.3
5	38	120	35	26	41	2.9	127	37.5	49	85	44	26	31	14	59	0.7	1.4
4	31	65	26	28	29	3.4	143	25	46	62	39	30	37	17	51	0.9	1.4
3 Standard	25	9	17	30	17	4.0	158	12.5	44	39	34	33	42	20	43	1.0	1.5
2	17	6	11	53	11	6.0	205	10	33	26	23	39	45	30	32	2.3	2.0
1	8	3	6	77	6	8.0	252	7.5	21	13	13	44	47	40	21	3.7	2.5
0 Lowest	0	0	0	100	0	10.0	300	5	10	0	2	50	50	50	10	5.0	3.0
Score																	
Weight (100)	2.8	3.6	2.6	2.5	2.5	1.8	3.8	2.6	4.5	4.9	1.4	3.8	3.4	5.2	50	2.7	1.9
Value																	

Performance Scale

PERFORMANCE INDICATOR /1000

Figure O.1: An example of the Objectives Matrix

APPENDIX O

REFERENCES

REFERENCES

REFERENCES

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MEDIA SENTRUM WERKKAART
MEDIA CENTRE JOB CARD

GRAFIES / REPOGRAFIE
GRAPHIC / REPOGRAPHY

KLIëNT / *CLIENT*

RANG / *RANK*	Kmdt	NAAM / *NAME*	H. Viljoen	EENHEID / *UNIT*	SAGD HK	DATUM / *DATE*	31/1/94
TELEFOON / *TELEPHONE*	6715341	ONDERWERP / *SUBJECT*	MChD Verhand	TEIKENDATUM / *TARGET DATE*	4/2/94		
UITBREIDING / *EXTENSION*	—						
AANTAL OORSPRONKLIKES / *NUMBER OF ORIGINALS*	390 x 12 = 4680	RUG AAN RUG / *BACK TO BACK*	JA / *YES* (X)	NEE / *NO*	GROOTTE / *SIZE*	A4 (X)	A3 / A5
KLASSIFIKASIE / *CLASSIFICATION*	UIT GEH / *TOP SEC*	GEH / *SEC*	VERT / *CONF*	BEP / *REST* (X)	TAAL / *LANGUAGE*	AFR (X)	ENG / ANDER / *OTHER*

PRODUK / *PRODUCT*

TIPE / *TYPE*				* MATERIAAL / *MATERIAL* DUI NOMMER AAN / *INDICATE NUMBER*			BIND		
BOEKE / PRECIS *BOOKS / PRECIS*	X	PLAKKAAT *POSTER*		PAPIER *PAPER*	X	DUI NOMMER AAN / *INDICATE NUMBER*	STAPLE :	GEWOON *NORMAL*	
ILLUSTRASIE *ILLUSTRATION*		UITNODIGING *INVITATION*		BUITEBLAD *COVER*				SAAL *SADDLE*	
VORMS *FORMS*		BRIEFHOOF *LETTERHEAD*		SERTIFIKAAT MATERIAAL ENS				HOEK *CORNER*	
SERTIFIKATE *CERTIFICATES*		ANDER *OTHER*		*CERTIFICATE MATERIAL ECT*			GUILLOTEEN *IBICO :*	SPESIALE MAGT NODIG	
							EASY BIND :	SPESIALE MAGT NODIG	

INHOUD EN ALLE INFORMASIE MBT TAAK / OORSPRONKLIKE GELEWER / VOORBEELDE / TIKWERK EN ALLE FASETTE VAN MY AANVRAAG IS KORREK.

CONTENTS AND ALL INFORMATION RELEVANT TO THE TASK / ORIGINAL HANDED IN / EXAMPLES / TYPE WORK AND ALL ASPECTS OF MY REQUISITION IS CORRECT.

HANDTEKENING ....

KANTOORGEBRUIK / *OFFICE USE*

MAGTIGING / *AUTHORITY* : .... • REEKSNOMMER / *SERIAL NO* : 5327

PROSES / *PROCESS*

GRAFIES *GRAPHIC*	DATUM AFGEHANDEL *DATE FINISH* :	REPOGRAFIES *REPOGRAPHY*	DATUM AFGEHANDEL *DATE FINISH* 02/02/94
OPERATEUR *OPERATOR*	:	OPERATEUR *OPERATOR*	:
GOEDKEURING *APPROVAL*	:	GOEDKEURING *APPROVAL*	:
BIND	DATUM AFGEHANDEL *DATE FINISH* :		
OPERATEUR *OPERATOR*	:		
GOEDKEURING *APPROVAL*	:		