

Chapter 1

Introduction

1.1 Introduction

The selection of students for higher education has been high on the agenda of South African institutions of higher education for the past decade. Louw (1992:1) states that the criteria used in the selection of prospective students for tertiary studies are being questioned more and more.

In addition, institutions for higher education have experienced an increase in applicant numbers since 1994, which soon led to demand exceeding available vacancies, and hence some sort of selection became essential. This situation is further complicated by the fact that there is limited public funding available for higher education, and by the marked differences in terms of their preparedness for higher education that exist amongst students from the previously differentiated school systems (Huysamen, 1996:199; Zaaiman, 1998:1).

Furthermore, institutions of higher education are being pressurised by government to increase demographic representation in their student populations, as well as to address the developmental needs of society better by rectifying the mismatch between the output of higher education and the needs of the modernising economy (Department of Education, 1997:8). In this respect, specific mention is made of the shortage of highly trained graduates in the fields of engineering, science, technology and commerce.

In addition to the above, there is the problem of extremely high attrition rates

experienced by institutions of higher education (Stumph, 1997:1). At Technikon Pretoria an average attrition rate of 34% has been recorded for first-year students in the period 1996 to 1999. This does not include the 35% of first-year students that failed more than half of their subjects.

Apart from the above considerations, there is the emotional suffering of those students who, through no fault of their own and despite hard work, simply are incapable of academic success at tertiary level (Huysamen, 1996:200).

It thus became imperative for a more effective system for managing access to be developed. Technikon Pretoria decided to investigate and develop an alternative selection strategy by means of which access could be increased. It was deemed extremely important that, whatever strategy was decided upon it should be fair, unbiased and effective.

Traditionally, Technikon Pretoria, as most other institutions of higher education in South Africa, has based its admission of students on scholastic academic performance. A Senior Certificate (or equivalent) was set as the absolute minimum requirement for admission. In some instances additional requirements were set, such as a minimum mark for Mathematic and Physical Science in the case of engineering technology courses.

As engineering is stated by government to be one of the focus areas for increased participation, it was decided that this study would look into a valid and reliable process by which potentially successful students could be admitted to Technikon Pretoria's Faculty of Engineering.

1.2 Objectives of the study

The main aim of this study was to develop a potential assessment battery for the

selection of engineering technology students at Technikon Pretoria, which would be both valid and reliable.

The second objective of this study was to deduce general selection guidelines for institutions of higher education from the research experiences and results.

1.3 Elucidation of key terms

In order to enhance the clear interpretation of the key terms used in this dissertation, those terms are explained below.

Selection

For the purpose of this dissertation the term "selection" will be used to refer to the process by which information regarding an applicant is gathered and evaluated in order to decide on his or her suitability for admission to higher education. Chapter 3 deals with this aspect in detail.

Assessment/selection battery

The set of subtests compiled for use in the determining of an applicant's potential to be successful in the relevant academic programme.

Potential

In this study "potential" is used to refer to the assumption that the ability to complete a simple task, indicates the potential to complete a more complicated, but related task. This is in accordance with verbal communication with Dr Pieter Erasmus, developer of the psychometric instrument used in this study.

Ability

For the purpose of this dissertation, the term "ability" refers to the capability to complete a task that has been set successfully.

Competency

This study concurs with the definition of Armstrong (1996:195) that competency refers to those behavioural characteristics needed to attain the required levels of performance.

Engineering Technology student

A student enrolled for a course in either Mechanical Engineering or Civil Engineering Technology at Technikon Pretoria.

1.4 Arrangement of chapters

In conclusion, a short description of the arrangement of the chapters of this study is given.

Chapter 2 deals with the debate on the admission of students to higher education: problems faced by institutions for higher education, as well as policies and demands from government, are looked into. Chapter 3 addresses the concept of selection in detail and Chapter 4 examines psychometric testing, and briefly looks at the related political, legal and scientific issues. Chapter 5 deals with the development of criterion variables. Predictors of academic success, as determined by previous studies, are explored in Chapter 6. Chapter 7 describes the Potential Index Batteries, the psychometric instrument used in this study, and Chapter 8 deals with the research methodology followed in the execution of the investigation. The sample used in the study is described in Chapter 9 and the statistic techniques used in the analysis of the data are described in Chapter 10. The determination of the predictor variables are dealt with in Chapter 11. The results of the data analysis process are given and discussed in Chapter 12. Finally, Chapter 13 deals with conclusions and recommendations. Suggestions for future studies are also made in this chapter.

Chapter 2

The admission of students to higher education

2.1 Introduction

Section 32(b) of the Constitution of the Republic of South Africa, 1996 (Act No. 108 of 1996), states that every person has the right "to further education, which the state, through reasonable measures, must make progressively available and accessible."

In addition, the Reconstruction and Development Plan (1994:66) of the African National Congress, states that the higher education system represents a major resource for national development and contributes to the worldwide advancement of knowledge. The central role higher education plays in the social, cultural and economic development in modern societies is emphasised by the White Paper on Higher Education (Department of Education, 1997:7).

The matter of access to higher education played a major role in the events that led to this study, and therefore, attention will be given in this chapter to admission requirements for higher education as well as to the participation rate in higher education. As some of the issues addressed by the White Paper on Higher Education impact directly on this study, it will be discussed briefly.

2.2 Admission requirements for higher education

Present admission requirements for higher education consist of a Senior Certificate as well as matric exemption, in the case of universities. All higher education institutions regulate additional entrance requirements autonomously. In many instances, degree and diploma programmes involving mathematics and science have such extended requirements, for example Engineering, Chemistry, Biotechnology and Food Technology. In some professional fields, such as Physiotherapy, admission is determined by the relevant professional body and limitations are placed on the number of students admitted for study.

Amongst others the minimum requirements set by Technikon Pretoria for admission to the engineering technology courses will be looked into by this study.

2.3 Participation in higher education

In 1993, the overall higher education participation rate in all post-grade 12 educational programmes in public and private education institutions was estimated at 20%. The participation rates of Whites at this time was "slightly less than 70%, while that for Indians was about 40%, for Coloureds 13% and for Africans about 12%" (Stumph, 1997:1). The discrepancies between the distribution of participation can clearly be seen, and Moody (1994:7) states that "access is the first step in the cycle of increasing black participation in higher education."

2.3.1 Increasing access by means of alternative/special admission methods

De Jager et al (1997:2) state that the term *special admission* is used internationally for the processes used in combination with regular admission procedures, in order to accommodate applicants who would not qualify for admission, should regular

criteria be applied. Special admission procedures are usually aimed at students whose matric results are below the standard required for admission at institutions for higher education, but who have the potential to benefit from higher education.

In the South African context the need for such an alternative admission process was created by the fragmented nature of the secondary school system of the past, as one of the implications of the inequalities in educational provision is the question of access (Kotze et al, 1996:39). This was caused by the fact that, traditionally, scholastic performance was used as major criterion to gain admission to higher education in South Africa.

An opposed opinion is offered by Huysamen (1997:65):

"In several countries, vehement criticisms have been raised against the use of admission tests. In South Africa, the possibility of admission testing has acquired an additional dimension insofar as it is believed that it would be harmful to efforts to increase tertiary-educational access for previously excluded demographic groups."

At Technikon Pretoria, where this study was executed, a system was developed whereby a prospective student is evaluated in terms of his or her potential to be successful in a chosen course. The Technikon Pretoria Potential Assessment (TPPA), as the process is known, is seen as a way of levelling the playing fields; of giving all applicants an equal chance of access, irrespective of their past academic achievements. In this way Technikon Pretoria has taken the "first step in the cycle of increasing black participation in Higher Education" (Moody, 1994:1).

2.4 The White Paper on Higher Education

The need for the reconstruction of higher education in South Africa, which resulted from racial and gender inequalities and apartheid-based education, has been given priority by the ANC government, and the National Commission for Higher Education was established by President Mandela in February 1995.

The publication of the White Paper on Higher Education, which outlines a comprehensive set of initiatives for the transformation of higher education, was the result of the activities of this Commission.

The White Paper on Higher Education sets a programme for the transformation of higher education in South Africa. It focuses closely on the purposes and challenges of such higher education (Department of Education, 1997:7-14). These aspects will subsequently be discussed.

2.4.1 The purposes of higher education

According to the White Paper on Higher Education (Department of Education, 1997:7), the purposes of higher education are as follows:

- Higher education should meet the learning needs and aspirations of individuals through the development of their intellectual abilities and aptitudes throughout their lives. It is therefore an important vehicle for achieving equity in the distribution of opportunity and achievement among South African citizens.

- Higher education should address the development needs of society and

provide the labour market with the ever changing high-level competencies and expertise necessary for the growth of a modern economy.

- Higher education should contribute to the socialisation of enlightened, responsible and constructively critical citizens.
- Higher education should contribute to the creation, sharing and evaluation of knowledge.

2.4.2 The needs of and the challenges facing higher education

The present system of higher education is limited in its ability to meet the moral, political, social and economic demands of the new South Africa (Department of Education 1997:8). According to the White Paper on Higher Education, the following deficiencies, *inter alia*, characterise the current higher education system:

- There is an inequitable distribution of access and opportunity for students and staff in terms of race, gender, class and geography and there are equally untenable disparities between historically white institutions and historically black institutions in terms of facilities and capacities.
- There is a chronic mismatch between the output of higher education and the needs of the modernising economy. There is a particular shortage of highly trained graduates in fields such as science, engineering, technology and commerce.
- Higher education has not adequately fulfilled its unmatched obligation to help lay the foundations of a critical civil society, with a culture of public debate

and tolerance which accommodates differences and competing interests.

2.4.3 Requirements for the transformation of higher education

According to the White Paper on Higher Education, the following requirements will have to be met to bring about a successful transformation of the higher education system and its institutions (Department of Education, 1997:10):

- *Increased and broadened participation.* Successful policy should increase access for Blacks and women; disabled and mature students.
- *Responsiveness to societal interests and needs.* Institutions should meet the needs of an increasingly technology-orientated economy.
- *Cooperation and partnerships in governance.* The relationship between the higher institutions and the state, civil society and stakeholders as well as those between institutions themselves will have to be considered.

The emphasis placed on the redress of the inequitable distribution of access in terms of race and gender by the White Paper on Higher Education had a strong influence on the current study.

In the past, the admission of students on grounds of scholastic achievement only placed many prospective students in a disadvantaged position (Kotze et al, 1996:39) and led to the comment on "inequitable distribution of access" by the White Paper on Higher Education (Department of Education, 1997:8). The development of selection methods that will make higher education more accessible for different race and gender groups is therefore in accordance with the guidelines set for the

transformation of higher education by the Department of Education.

In addition, the shortage of qualified graduates in engineering and technical fields addressed by the White Paper on Higher Education (Department of Education, 1997:8) also impacts on this study. The difficulties experienced by the Engineering Faculty at Technikon Pretoria in producing the required number of qualified technicians will be discussed in Chapter 6. Suffice it to say here that admitting the student with the best potential to be successful in the course of his or her choice, would help to rectify the mismatch between the output of higher education and the needs of the economy, as addressed by the White Paper.

2.4.4 Vision

The Ministry of Education envisages a system of higher education that will, *inter alia*, “promote equity of access and fair chances of success to all who are seeking to realise their potential through Higher Education, while eradicating all forms of unfair discrimination and advancing redress for past inequities.” (Department of Education, 1997:11.)

2.4.5 Principles

According to the White Paper on Higher Education (Department of Education, 1997:11), the Ministry of Education regards eight principles as fundamental. However, only the four principles that are relevant to this study will be discussed here.

- **Equity and redress.**

This principle implies fair opportunities for entering higher education programmes and succeeding in them. Such transformation would abolish all

existing forms of unfair differentiation.

■ **Quality**

The quality principle refers to the maintenance and application of academic and educational standards, “both in the sense of specific expectations and requirements that should be complied with, and in the sense of ideals of excellence that should be aimed at.” (Department of Education, 1997:12.)

■ **Institutional autonomy**

The principle of institutional autonomy implies a high degree of self-regulation as far as, *inter alia*, student admission, curriculum, methods of teaching and assessment are concerned.

■ **Public accountability**

“The principle of public accountability implies that institutions are answerable for their actions and decisions not only to their own governing bodies and the institutional community, but also to the broader society.” (Department of Education, 1997:13.)

The influence of the above principles on the study conducted here is clear: a selection battery which has predictive validity should give all a fair opportunity for entering higher education, and the success rate of the students admitted should be predictable. Furthermore, the quality of academic and educational standards would be determined by the potential of the student admitted. By using a battery such as the one suggested in this study, the institution would regulate its own student admissions and be publically accountable, as empirical research results regarding the predictive validity will be readily available.

2.5 Implications of legislation on current practices in higher education

According to Stumph (1997:5), the White Paper on Higher Education contains a “clear and unambiguous commitment to the promotion of equity of access and fair chances of success to all who are seeking to realize their potential through Higher Education.”

Bodibe (1997:6) states that the management of access will, in future, imply moving away from exclusive access to access which guarantees equal opportunities to all groups previously disadvantaged.

In addition, according to the National Qualifications Framework, provision will have to be made for appropriate entry points for all prospective learners “in a way that facilitates progression” (Human Sciences Research Council, 1995:1). Recognition will also have to be given for all prior learning and other relevant competencies.

In the development of a potential assessment battery for prospective students evidence will have to be accumulated towards the principle of broadening access. Equal opportunities for access will have to be guaranteed. Furthermore, in the final selection, prior learning and industry related-experience that may enhance a student’s chances to be successful, will have to be recognised.

2.5.1 Curriculum 2005

The implementation of Curriculum 2005 by the Department of Education will lead to the phasing out of the National Senior Certificate, which is currently the requirement for admission to higher education institutions. A pass in the Further Education Training

Certificate (FETC) will in future be the minimum statutory requirement for admission to higher education (Stumph, 1997:8). Institutions will however continue to have the right to determine entry requirements where they consider it to be appropriate over and above this statutory minimum. In affording them this right, the White Paper on Higher Education explicitly emphasises that such additional requirements should ensure that selection criteria are sensitive to the educational backgrounds of learners. Furthermore, such selection criteria should "incorporate the recognition of appropriate prior learning, including learning that took place in less structured and formalized environments than those typically encountered in our education system only" (Stumph, 1997:9).

2.6 Financial implications of student pass rates

As higher education institutions receive the bulk of their government subsidies for successful students, the "increasing financial burdens of Higher Education institutions likewise imply that institutions will no longer be able to bear the burden of unsatisfactory study progress by students" (Stumph, 1997:14). Pienaar (1991:9) agrees that higher education is cost-intensive and therefore it will become more and more important to select only students for higher education who have a chance of being successful.

According to Stumph (1997:2) the official average pass rate for students enrolled at South African technikons for three year diplomas was 15% for historically white institutions and 9% for historically black institutions in 1990. Official records for Technikon Pretoria show that 35% of the students registered as first year students in 1996 dropped out of their courses by the beginning of 1997. As was said earlier, this figure does not take into account the 34% of first-year students that failed more than half their subjects (Technikon Pretoria: Strategic Information and Planning, 1998).

2.7 Conclusion

The face of higher education in South Africa is set to change. The Constitution of the country gives all people the right to further education through it the State has committed itself to broadened access and availability.

Furthermore, the Department of Education has undertaken in its White Paper on Higher Education to address the mismatch between the "output of Higher Education and the needs of the modernising economy" (1997:8). In terms of the White Paper, this specifically refers to scientific, engineering and technology fields.

Hand in hand with the principle of the maintaining of standards goes the financial burden that unsuccessful students place on institutions for higher education. Higher education institutions could either drop their standards and in so doing increase their throughput statistics to increase their government subsidies, or maintain their standards, but ensure that the students they admit have the potential to be successful in their chosen courses.

The implementation of Curriculum 2005 is furthermore forcing higher education institutions to reconsider their present admission requirements and investigate alternative admission procedures.

From all the arguments above, it is clear that some innovative measures have to be developed to enable higher education institutions to select potentially successful students. A potential assessment programme with scientifically proven predictive validity is suggested as such a measure to ensure that those students with the best chance to pass would be admitted to higher education and that the institution concerned would benefit financially from the achievements of its students.

Chapter 3

Selection

3.1 Introduction

Kotze (1994:15) states that various aspects should be taken into consideration when a selection process for higher education is developed. In this chapter attention will be given to theoretical principles involved in designing a selection process and the application of those principles to a prediction model. Subsequently, the concept of fairness in selection will be discussed. In conclusion, a close look will be taken at performance prediction models.

3.2 Defining the concept

Blake (1983:237) defines selection as "the process of choosing, from those available, the person or people who best meet the requirements of a position or positions vacant within an organization."

Leap and Crino (1993:237) continue by stating that the purpose of selection is to discriminate fairly between applicants. "A firm must be able to separate applicants who will perform well as employees from applicants who will not" (Leap and Crino, 1993:237).

In the context of this study, "selection" will refer to the process of choosing the potentially successful student rather than the potentially successful employee.

3.3 Principles underlying the development of a selection procedure

During the past decades that make up the history of personnel selection, little attention has been given to the construction of integral selection procedures to be used in practical conditions (Roe & Greuter, 1991:190). In order to address this shortcoming, Roe (1989:129) developed a model for the design of selection procedures, which will now be discussed in detail.

3.3.1 The design cycle concept of Roe

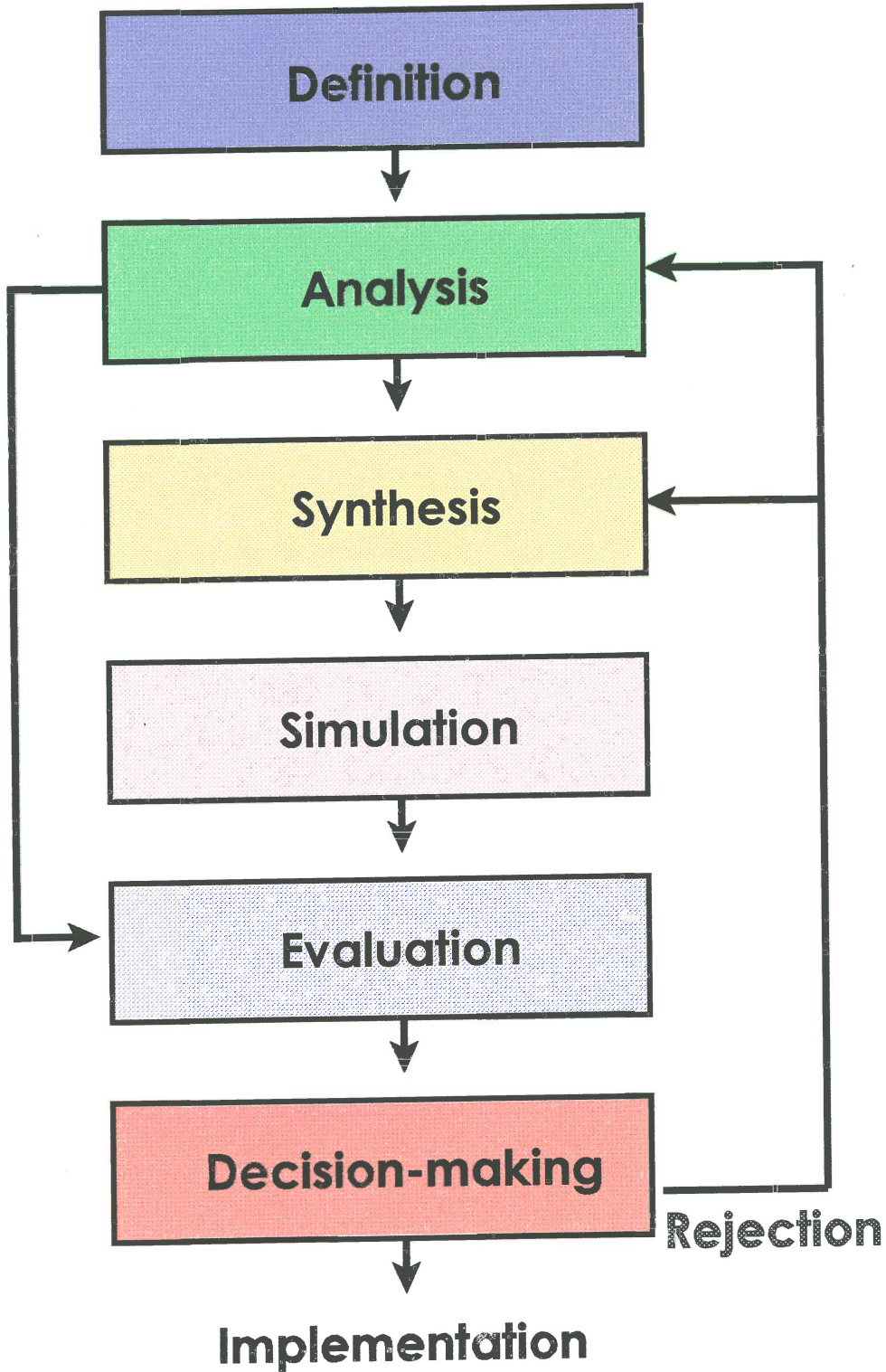
Roe takes the concept of the design cycle from the engineering sciences. It specifies a number of steps that have to be taken within the framework of an iterative process. Although that concept could be used in the design of any product, Roe specifically uses it for designing an integral selection procedure (Roe, 1989:129).

The steps of the design cycle are presented in Figure 3.1 and will be discussed below (Roe, 1989:129-130).

3.3.1.1 Definition

According to Roe, the first step in the design cycle is to define the purpose of the selection procedure and to determine the functions it should fulfil in its particular context. In general, selection procedures are used to collect information, make predictions of performance, evaluate performance and facilitate decisions. These

Figure 3.1: The design cycle model as adapted from Roe (1989:129)



functions can be said to be context-dependent.

3.3.1.2 Analysis

The second step in Roe's model involves the derivation, from the functions to be carried out of requirements that the procedure should meet. These may involve the input data, the prediction, the decision, etc. The constraints influencing the procedure should furthermore be specified, for example, time and resource limitations.

3.3.1.3 Synthesis

The next step is creating a preliminary design or adjusting an existing process in such a way that it fulfils the desired functions, and at the same time, stays within its restrictions. Synthesis is a creative activity, utilising knowledge about people and their behaviour as well as available tools and techniques, to reach an innovative solution for the selection issue at hand. "The result of synthesis is a description of the selection process " (Roe, 1989:130).

Synthesis may include specifications, such as a minimum predictive validity.

3.3.1.4 Simulation

In this step, the operational, predictive and economic properties of the selection procedure are evaluated. Simulation can be carried out on an empirical basis by having experimental runs or by using models such as the Taylor-Russel tables, Curtis and Alf tables or the Cronbach-Gleser formulae for estimating utility.

3.3.1.5 Evaluation

As soon as the properties of the selection procedure are known, their value for the user can be assessed, taking the functions and restrictions into consideration. This step should prove the procedure either satisfactory or unsatisfactory.

3.3.1.6 Decision making

The last step in the designing cycle is to accept the procedure for operational use or to reject it. In the case of rejection, the process may start again at Step three, revising the model in order to improve the previous solution. If errors or insufficiencies in the programme of requirements and limitations show up, the process may return to Step two and the requirements and constraints could then be reformulated.

According to Roe (1989:130), the principle of iteration is typical for the designing process, as a satisfactory solution is usually only found after a number of efforts. The design cycle can be utilised equally well to develop new selection processes and the redesign of existing procedures.

3.3.2 Major functions of the selection procedure

According to Roe (1989:131-137), the following are the most common functions that selection procedures have to fulfil.

3.3.2.1 The information-gathering function

To be able to select an employee for a position in an organisation, specific information regarding both the organisation and the applicant is needed, such as the position and minimum requirements or abilities and traits of the applicant. In the

case of developing a selection procedure for admission to higher education, information involving the relevant academic course as well as information on the applicant will have to be accumulated.

The most important choices to be made concerning the information-gathering process are which content area is to be covered and in which format the information will be presented. The outcome of these choices will determine the instruments and techniques to be employed in order to gather the relevant information

3.3.2.2 The prediction function

Within the selection process expectations about future behaviour of applicants are derived from past or present characteristics. Both Roe (1989:133) and Greuter (1989:186) refer to two main predictive principles, namely, the sign approach and the sample approach. The two approaches differ in their underlying epistemological basis and lead to different types of diagnostic processes and the utilisation of different instruments. (Roe, 1989:133.)

3.3.2.2.1 The sign approach

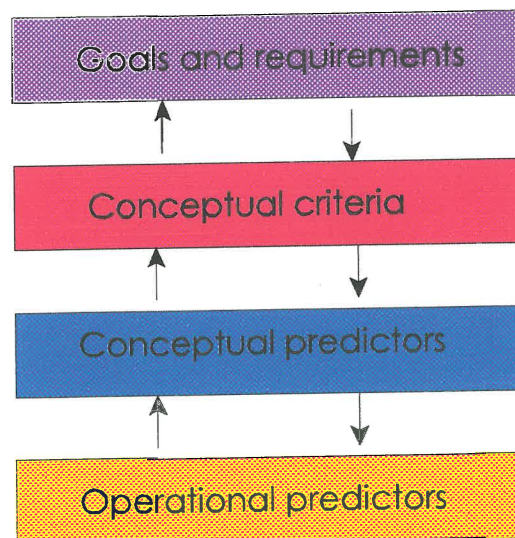
According to Roe (1989:133), the sign approach is based on the *deductive-nomological* principle. This means that for a given set of people, "when...a certain law states that a relationship exists between a characteristic A and a certain type of behaviour E, one can deduct from this law the prognostic proposition that a person who possesses A will show behaviour E." (Roe, 1989:133.)

Figure 3.2 shows the diagnostic process according to the sign approach, as

presented by Roe (1989:134). The process has two phases. The first is an analytical or downward phase, during which diagnostic indicators are identified. First, a description of the organisations goals and requirements are given, whereafter conceptual criteria are specified. These criteria should correspond to relevant dimensions of work behaviour and performance results. Conceptual predictors are chosen on the basis of the differential psychology ("laws" previously referred to). "Finally, the conceptual predictors, which have a well-defined theoretical status, or construct validity, are operationalized by choosing, or developing, certain operational predictors, such as cognitive tests, personality inventories and rating scales." (Roe, 1989:134.)

In the second, or upward, phase of the diagnostic process corresponding to the sign approach, the order is reversed. The first step is to administer operational predictors and the second to make inferences on applicants' traits (conceptual predictors) and work behaviours (conceptual criteria). Finally conclusions are drawn regarding an applicant's predicted success in terms of the organisation's expectations.

Figure 3.2: Diagnostic procedure in the case of the sign approach (Roe, 1989:134)



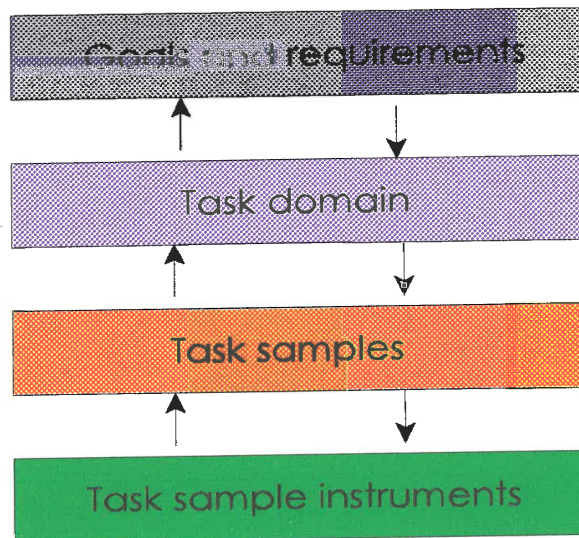
3.3.2.2.2 The sample approach

Greuter (1989:187) states that the sample approach refers to prediction in terms of iconic or analogue models. Roe (1989:133) says that the sample approach -

“...rests on the principle of generalization: when a person behaves in manner E at a given occasion defined by time and place, it is concluded that he or she will behave identically on other occasions belonging to the same universe.”

Figure 3.3 shows a diagnostic process corresponding to the sample approach as presented by Roe (1989:135). The process starts with a description of the organisation's goals and requirements. The second step entails the defining of the domain of tasks corresponding to the relevant position. In the third step a sample is drawn from the domain of tasks set in the second step. This sample is operationalised in a set of activities, such as biographical questionnaires, situational tasks, etc. The results are interpreted in terms of the performance on the task sample, the total task domain and job success.

Figure 3.3: Diagnostic procedure in the case of the sample approach (Roe, 1989:135)



According to Roe (1989:135), the two approaches can be implemented in either a clinical or formalised method and the combination leads to four different forms of prediction, namely:

- *Nomological model*: The model contains a formalised specification of the relationships of one or more predictor variables, operational measures of traits and one or more criterion methods.
- *Domain sampling model*: Content-oriented devices are used to measure past or present performance; scores are generalised in a formal way (for example, statistically) to future performance estimates.

- *Predictor comparison* The scores of applicants on predictor variables are compared in order to find those with the best overall profile. It is assumed that this person's performance will be the best.
- *Criterion analogies*: The work performance of applicants in similar situations are analysed in order to draw analogies. In this way, an idea of future performance is derived from past performance.

3.3.2.3 Decision-making function

The third main function of the selection process, according to Roe (1989:136), is that of decision-making. Although expectations about applicants' future performance play an important role, they do not constitute the end result of the selection procedure. A decision strategy should be generated, which is broadly speaking a way of weighting utilities and probabilities of outcomes and finding the optimal outcome. A formal or informal way of decision-making can be used.

3.3.2.4 Information supplying function

The final main function of selection is the supplying of information about assessment results, expected performance of applicants and decisions taken, to the relevant role players (Roe, 1989:137).

3.3.3 Applying the design cycle to predictive performance models

Greuter (1989:183) says the design cycle as suggested by Roe (1989:129) can be applied to each of the basic functions of the selection process as discussed above. His application of the design cycle to predictive performance models will be

discussed in detail here, as it has significance for this study.

According to Greuter (1989:183), prediction models can be seen as special cases of performance models.

“In a performance model the performance criteria under study are explicitly related to a set of exogenous variables. Exogenous variables can be conceived as determinants of the performance behaviour under study. They serve to predict the future outcomes of performance criteria or they may facilitate the understanding of performance behaviours.” (Greuter, 1989:183.)

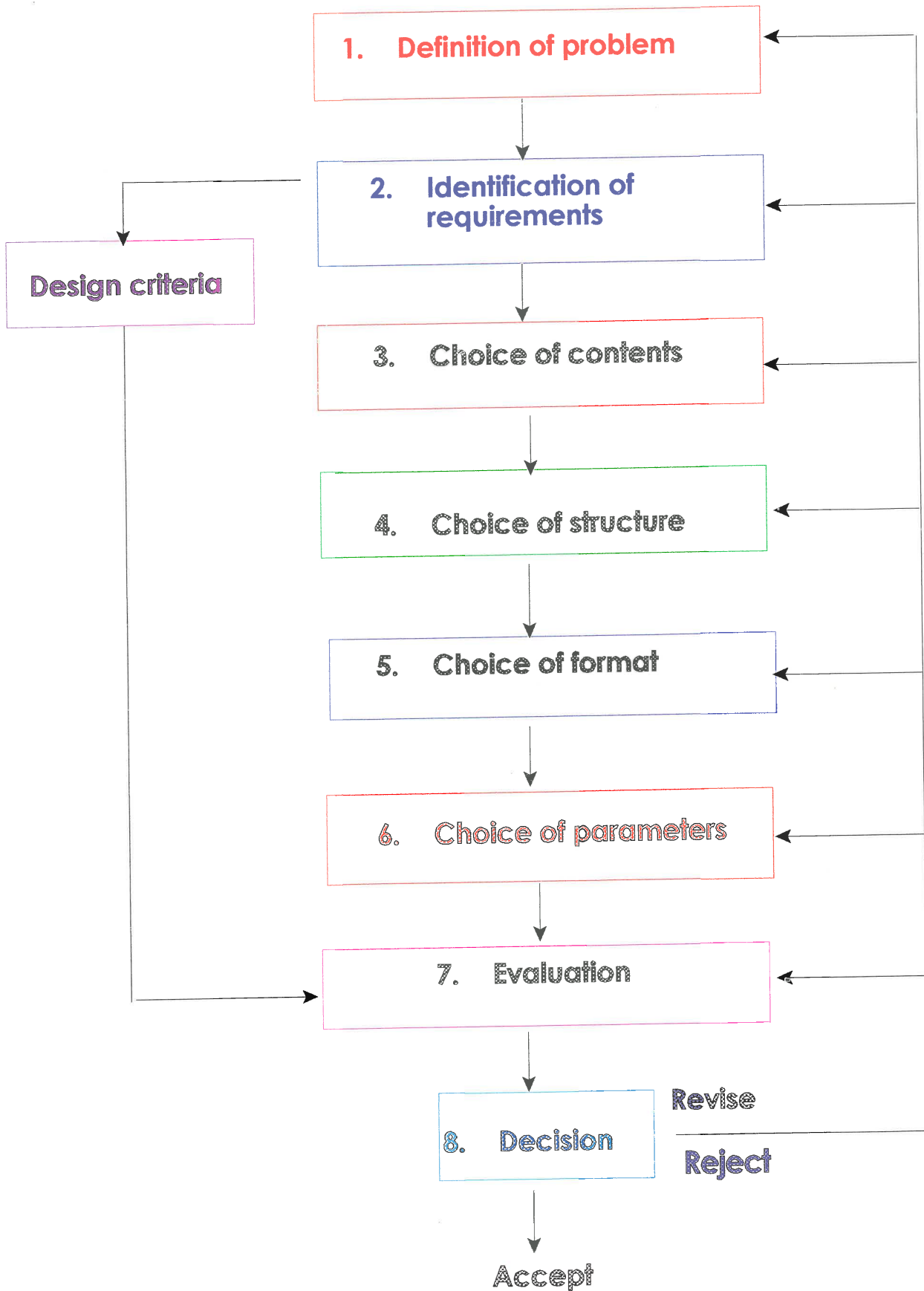
Greuter (1989:184) continues by saying that, in selection, a performance model should contain variables that -

- are relevant to the problem at hand
- can be assessed at the moment of application
- are stable enough to allow predictions over a longer time period
- are streamlinable in order to get an acceptable utility-cost ratio

Greuter (1989:185) defines a prediction model, in the context of personnel selection, as “a model that transforms information about applicants' past or present behaviour into forecast of their future behaviour.” Prediction models can vary from statistical regression formulae to job simulations.

Figure 3.4 shows Greuter's application of Roe's design cycle (Greuter, 1989:184), to indicate which steps are to be taken to develop predictive performance models. Each of the steps will be described below.

Figure 3.4: Steps in the development of predictive performance models in accordance to the design cycle model. (Greuter, 1989:184)



3.3.3.1 Steps in developing prediction performance models for selection

3.3.3.1.1 Defining the problem

Performance models aim to predict the success of applicants from the specific characteristics and/or behaviour styles as assessed at the time of their selection. The question asked can thus be restated by formulating predictive performance models that can transform information on past or present applicant characteristics into predictions about future performance.

3.3.3.1.2 Specifying model requirements

Predictive validity constitutes the main model requirement, as predictive performance models should allow for accurate predictions of work performance. Models should furthermore be both practical and economical.

3.3.3.1.3 Specifying model content

Relevant criterion variables should first be specified. Thereafter predictor variables must be identified so as to be able to predict expected performance levels on these specified criterion variables.

3.3.3.1.4 Structure

After the relevant model elements have been chosen, the relation between these elements should be specified. The focus should be on relations within and between both sets of variables (i.e. criterion and predictor variables).

3.3.3.1.5 Form

An algebraic function is usually chosen to depict the relationship between criterion and predictor variables in a performance model, for example $Y = f(X)$.

3.3.3.1.6 Estimating parameters

Model parameters are estimated in order further to specify the relationship between criterion and predictor variables. Parameters contain information about the strength of the relationship concerned. They relate to the specification of the model's structure according to which the direction of a relationship is depicted.

3.3.3.1.7 Evaluation of the model

The performance model is evaluated in relation to the model requirements specified at the beginning of the process. Evaluation is primarily directed at determining predictive validity, and the model is assessed in terms of practical and economical considerations.

Model revisions may be necessary as a result of the evaluation process, in which case all of the steps discussed might need to be repeated, until the final results are satisfactory.

3.3.4 Considerations in the design of selection procedure

Roe and Greuter (1991:217) identify four types of considerations that may play a role in the design of a selection process:

- ⇒ Effectiveness considerations: The appropriateness of the predictive information and the correctness of the decisions taken are taken into account. These considerations influence the selection of, for example, specific psychometric tests or the inclusion of certain questions in the biographical questionnaire.
- ⇒ Efficiency considerations: The relationship between the overall costs of the selection procedure and the benefits derived from its utilisation is assessed.
- ⇒ Ethical considerations: Aspects such as the non-intrusion of privacy, right to appeal and fairness of the process are considered. These considerations may for instance result in the setting of different selection ratios for applicants of different cultural backgrounds.
- ⇒ Managerial considerations: The organisation of the staff members involved in the selection process is evaluated. These aspects may for example, lead to the automation of parts of the process to cut labour costs.

It seems that the technological model suggested by Roe and applied by Greuter, offers an adequate framework for dealing with all of the above mentioned considerations that should be taken into account in the development of a selection procedure. This model will therefore be applied in the execution of this study.

3.4 Redefining “fairness” in selection

According to Arvey and Sacket (1993:172), psychology, for a very long time, treated fairness as a psychometric characteristic of a selection device. They refer to Hunter and Schmidt as being the first theorists to clarify fairness as a philosophical issue, and

not as a technical characteristic of a psychometric test.

This view has gained popularity in the ensuing period and it is now reflected in current professional standards. The Society for Industrial and Organizational Psychology states in its official Principles for the Validation and Use of Personnel Selection Procedures that -

“...fairness is a social rather than a psychometric concept. Its definition depends on what one considers to be fair. Fairness has no single meaning, and, therefore, no single statistical or psychometric definition. Fairness, or lack of fairness, is not a property of a selection procedure, but rather a joint function of the procedure, the job, the population, and how the scores derived from it are used” (1987:18).

Support for the expansion of the definition of fairness is also voiced by the American Educational Research Association, American Psychological Association and the National Council of Measurement when they state that “unlike selection bias, however, fairness is not a technical psychometric term; it is subject to different definitions in different social and political circumstances” (1985:13).

Arvey and Sacket (1993:173) add to the above by describing the selection system content, context, process, and outcome factors, all as potential contributors to fairness.

3.5 Strategies for selection fairness

Huysamen (1996:200) states that there are “various strategies or models by means of which selection variables may be combined to reach a decision whether to reject an

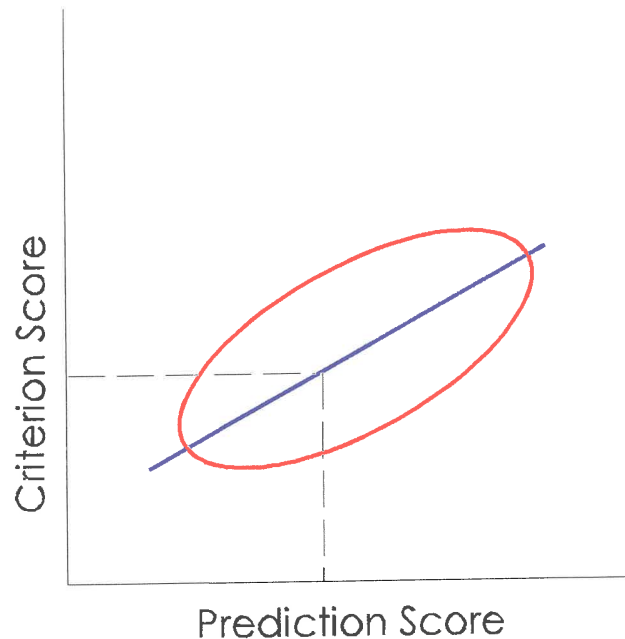
applicant to an institution of higher education." The most prominent of these will be discussed in order to motivate the decision on the strategy chosen for this study.

3.5.1 The regression models

Huysamen (1996:200) states that regression models choose predictor variables in terms of their ability to predict the criterion of future performance. Taylor and Radford (1986:83) elaborate by saying that the point of departure of the model is the assumption that fairness is achieved in that the applicants with the highest predicted criterion scores are selected, on condition that separate regression equations are used in a case of differential validity between groups.

Cascio (1991:180) states that the comparison of regression slopes and intercepts for various subgroups is widely advocated as a means of investigating selection fairness. He explains that in utilising such a model, predictions are made by drawing a line from any predictor score on the horizontal axis up to the regression line and another line from that intersection across to the vertical axis where the estimated criterion score is indicated (Figure 3.5). Huysamen (1996:200) adds that, if the predictor variables are independent of each other, this equation weighs them proportionally to their respective correlations with the criterion. By implication, poor performance on one criterion can be compensated for by better performance on others. According to Cascio (1991:180,) this model can be used fairly as is if "(O)ver all persons (a) the average error in prediction is zero, and (b) the variance of the errors of prediction is a minimum."

Figure 3.5: Prediction from a single group regression line (Cascio, 1991:180)

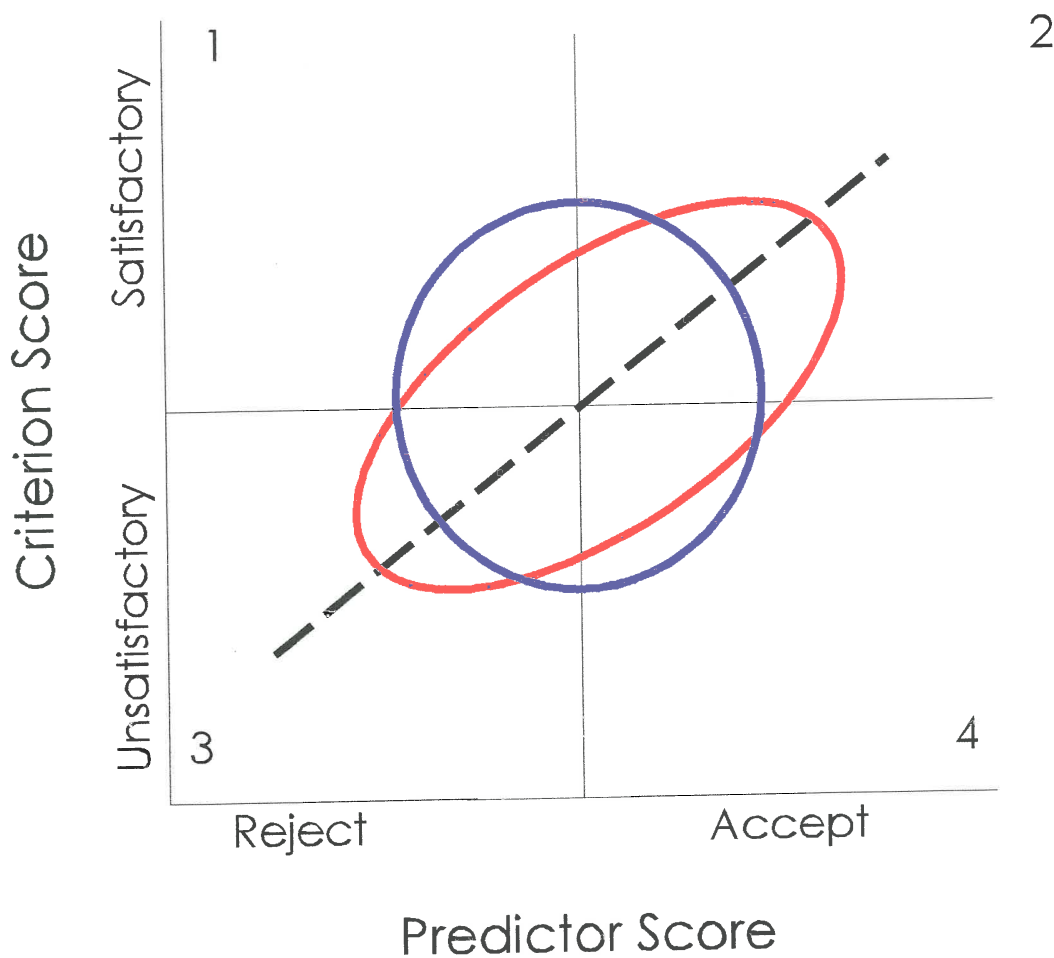


Although Taylor and Radford (1986:83) state that no explicit provision is made by the regression model for affirmative action, Huysamen (1996:200) feels that there is nothing that prevents the use of different combinations of predictor variables for different demographic groups. "For each demographic group one may simply use the prediction equation that maximises the prediction of academic performance at the institution involved" (Huysamen, 1996:201). Taylor and Radford (1986:84) suggest that quotas could be incorporated in this model if separate regression lines indicated the need for differential treatment of groups. According to Huysamen (1996:201), a test shows predictive bias if it consistently overpredicts or underpredicts the criterion performance of a specific group. Statistically, this predictive bias is revealed in the regression lines (criterion on predictor) being different for the various groups.

In cases where the distribution forms an **ellipse** (Figure 3.6) a valid prediction is indicated, that is, testees with a low predictor score perform low on the criterion

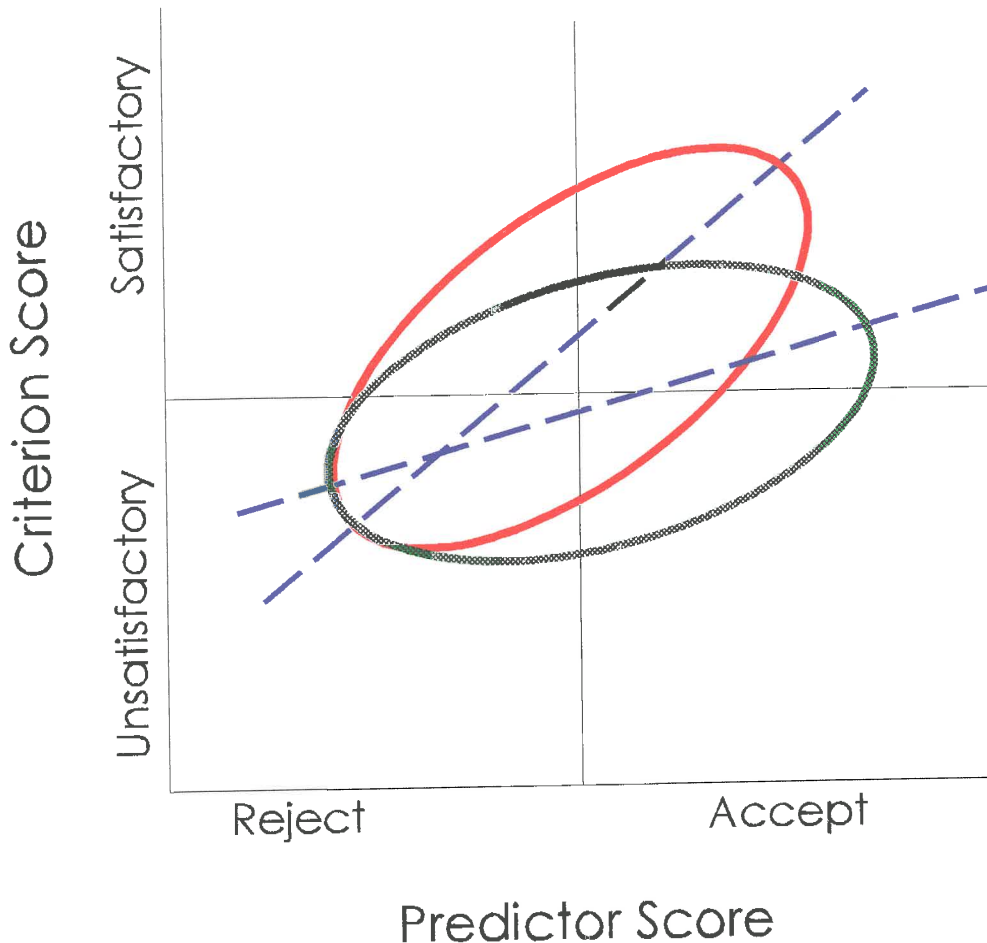
score and those with a high predictor score perform high on the criterion score. Cases falling in quadrants 1 and 3 represent correct decisions, cases in quadrant 4 are erroneous acceptances and those in quadrant 2 are erroneous rejections.

Figure 3.6: A graphic presentation of the distribution of scores in cases of positive validity and zero validity (Schaap, 1995:25)



If the distribution forms a circle (Figure 3.6), there is no predictive validity, as the cases are distributed evenly over all four quadrants and the number of cases correctly predicted does not differ from the number of cases incorrectly predicted.

Figure 3.7: Different regression lines and coefficients (Schaap, 1995:25)

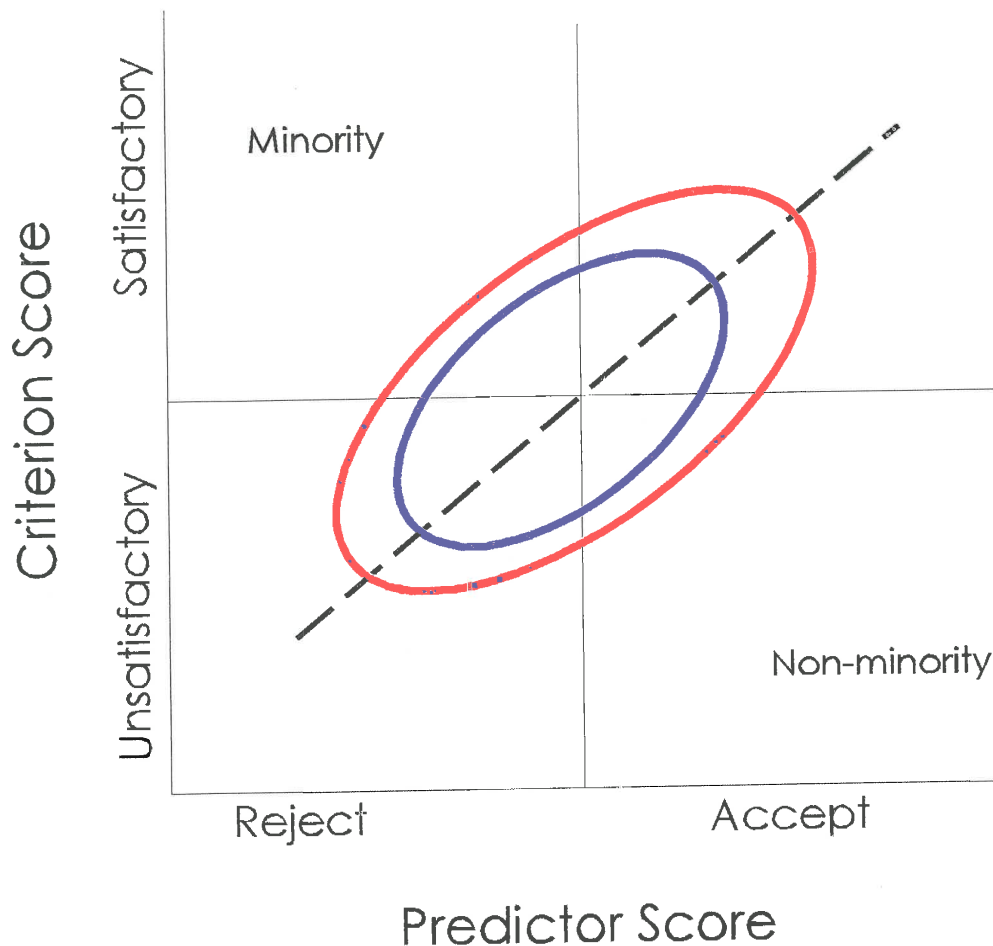


If a test shows different regression lines and coefficients for different groups, it has different meanings for different groups, which is indicative of serious test bias (Schaap, 1995:24). This distribution can be seen in Figure 3.7.

Cascio (1991:180) feels that when two subgroups are compared there are three basic possible situations. Figure 3.8 shows the first such possibility - although there are two separate ellipses, one for each subgroup, a single regression line may be cast for both groups. The position of the regression line will be invariant for the two groups,

whether calculated together or not, thus there is no need for separate predictions.

Figure 3.8: Valid predictor with adverse impact (Cascio, 1991:173)

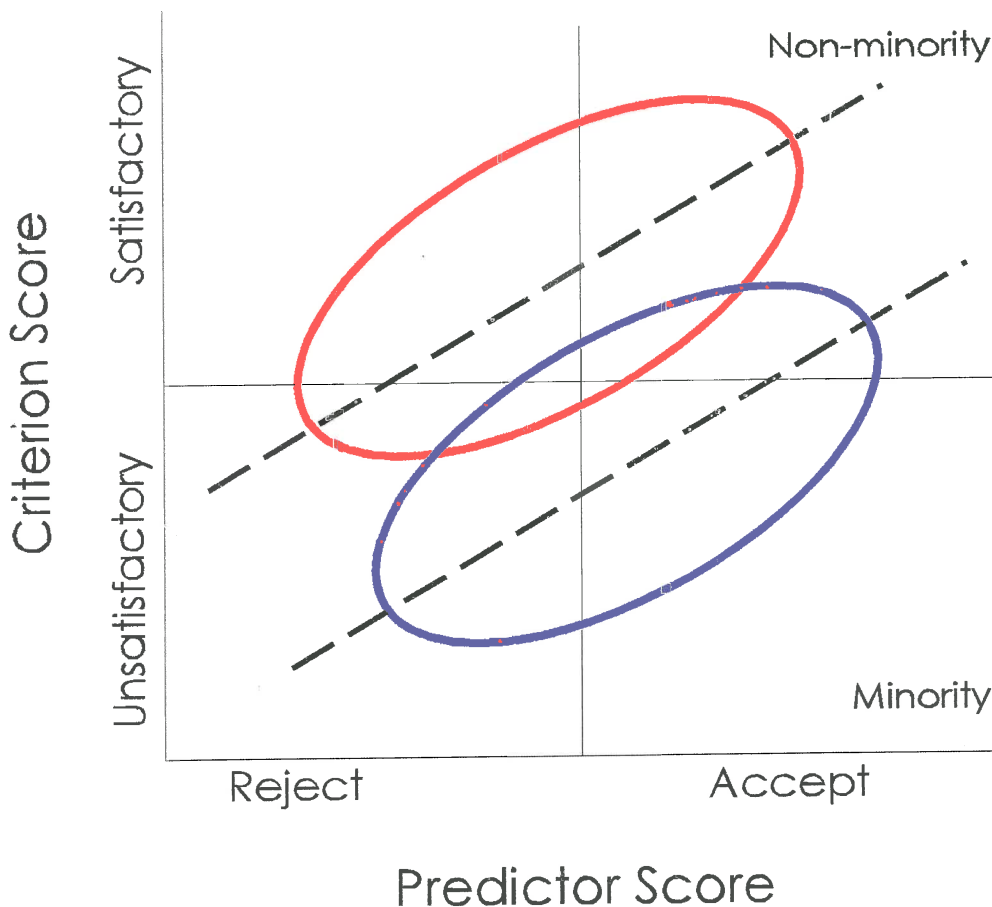


In Figure 3.9, the way in which the position of the regression line is calculated will make a difference. If a single regression line is cast for both groups, criterion scores for the non-minority group will consistently be underpredicted and those of the minority consistently overpredicted. If a single regression line is used, the non-minority group will, in this situation, be affected negatively. Even though the slopes of the two

regression lines are parallel, the intercepts are different and the same predictor score has a different predictive meaning in the two groups (Cascio, 1991:181).

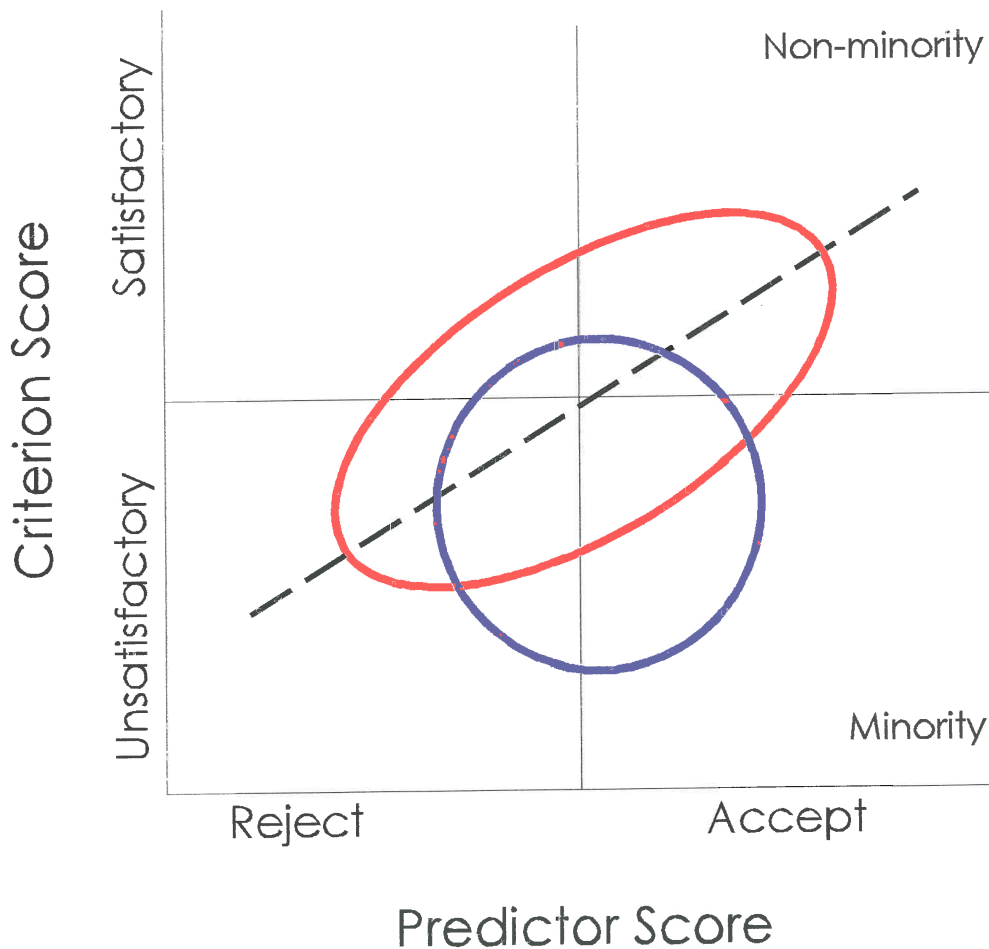
The third possible situation is depicted in Figure 3.10. In this situation the intercepts cross because the slopes of the regression lines are not parallel. The predictor is clearly inappropriate for the minority group in this instance. When the regression lines are not parallel, the predictive validities differ and the intercept differences are meaningless (Cascio, 1991:181).

Figure 3.9: Equal validity, unequal criterion means (Cascio, 1991:174)



Cascio (1991:181) concludes that, despite these potential difficulties, the consensus seems to be that regression models are the appropriate tests for selection bias. The accumulated evidence according to him is clear: "Lower tests scores among minorities are accompanied by a lower job performance, exactly as in the case of the majority" (Cascio, 1991:181).

Figure 3.10: Unequal criterion means and validity only for the non-minority group (Cascio, 1991:175)



3.5.2 Equal risk model

According to the model of Einhorn and Bass (1971:262), a selection model is considered fair if those selected have the same risk of failure, irrespective of their group membership. The distribution of criterion scores about the regression line is examined and separate cut-off scores (minimum predictor scores) should be set if groups have different probabilities of success. The developers of this model emphasise that it is the difference in the standard errors of estimate between subgroups that determines selection fairness. Cascio (1991:182) comments that this method has the same practical implications than the regression model - in groups with equal criterion means, lower predictive validity in one group may decrease the chances of selection for members in that group.

Referring to the ellipse form in Figure 3.6, in this model the probability of success for those selected is the same for different groups when the ratio of the number of cases in quadrant 1 to the number of cases in quadrants 1 and 4 combined is the same for both groups (Cascio, 1991:184).

3.5.3 Constant ratio model

According to Taylor and Radford (1986:84,) the constant ratio model, as proposed by Thorndike, aims at achieving equality of opportunity for different groups. Thorndike (1971: 63-70) proposes that in a fair selection procedure, the cut-off scores are set in such a way that the measure selects the same proportion of minority applicants that would be selected on the basis of the criterion itself or on a perfectly valid selection measure. That is, if 60% of group A and 50% of group B was successful in terms of the criterion, then fair selection would imply a proportional selection of group A relative to group B, at a ratio of 60:50. Cascio (1991:183) comments that Thorndike's model suffers from several disadvantages:

“It is another form of quota setting, it yields overprediction of minority group criterion scores in most situations, and it leads to a greater incidence of placements of individuals into occupational roles for which they are psychologically unsuited. This overprediction for minorities means that certain non-minority applicants will be rejected in favor of minority applicants with lower probabilities of success on the criterion (reverse discrimination). Hence, the overall level of performance will decrease considerably.”

Referring again to the ellipse form in Figure 3.6, in the constant ratio model, a selection procedure would be fair as long as the cases in quadrant 2 equal the number of cases in quadrant 4 (Cascio, 1991:184).

3.5.4 Conditional probability model

A fourth model of selection fairness is proposed by Cole (1973:250) and is also aimed at achieving fairness in the relevant proportions of the applicant groups. All applicants who would probably succeed if selected should be guaranteed an equal (or fair) opportunity to be selected, regardless of group membership. Taylor and Radford (1986:84) comment that both this model and the constant ration model “attempt to establish a parity among groups which in effect sets quotas for these groups.”

In the conditional probability model, the emphasis is on the proportion of applicants who are above the criterion cut-off. In terms of Figure 3. 6 (the ellipse form), the focus is placed on the ratio of the number of cases in quadrant 1 to the number of cases in quadrants 1 and 2 combined. If this ratio is equal for all subgroups being compared, the selection procedure is considered fair (Cascio, 1991:184).

3.5.5 Modified criterion/Subjective regression model

In this model, Darlington (1971:73) distinguishes between the utilisation of a test to maximise criterion validity and to give preferential treatment to disadvantaged group members. A value judgement is made about the desirability of special selection of members of some group. If special selection is desired, some difference in criterion scores between the groups is adopted, which will yield equally desirable applicants from each group. This is achieved by utilising a formulae by which criteria score Y for a minority group is desirable as a score of $Y+k$ for non-minorities. Using a variable C (with a value of zero for minorities and one for non-minorities), the new criterion will be $Y-kC$.

Cascio (1991:182) calls this method an “esoteric way of setting quotas”. He qualifies his remark by explaining that adding or subtracting a constant to the criterion is mathematically equal to adding or subtracting a constant from the predictor score, which in turn is equal to using different cut-off scores for different groups.

In the subjective regression model a selection measure is considered culturally optimal if the proportion of scores for each group in quadrants 2 and 4 (Figure 3.6) is equal (Cascio, 1991:184).

According to Cascio (1991:185), these five models illustrate that there is more than one reasonable definition for fairness and each definition has some practical and ethical implications which may conflict in some cases. Ultimately, the solution will not be in statistical calculations alone, but also in some values that will need to be weighed. He continues by stating that broader considerations need to receive attention because the validity coefficient by itself falls short of an adequate description of the relative usefulness of the selection decision procedure.

3.6 Decision-making for selection

Selection decisions are concerned with the assignment of individuals to treatments of courses of action which are important to the individual and/or the organisation involved. As the outcome such a decision is not known beforehand to the decision-maker, it has to be predicted on the grounds of available information. This prediction procedure consists of two steps, namely:

- *Measurement*: the collecting of data relevant to the task performance by utilising tests and other assessment tools.
- *Prediction*: the combination of relevant data to ensure a minimisation of predictive error in forecasting task performance (Cascio, 1991:279).

Traditionally, according to Cascio (1991:279), selection programmes had measurement accuracy and predictive efficiency as final goals. This approach has been severely criticised, as it ignores certain external parameters of the situation which have a large impact on the overall usefulness of a selection procedure (Cascio, 1991:292). Two such parameters are the following:

- *Selection ratio*: the ratio of the number of vacancies to the total number of applicants.
- *Base rate*: the proportion of persons judged as successful by using current selection procedures.

Cascio (1991:292) feels that over and above ignoring the aforementioned parameters, the classical validity approach makes unwarranted utility assumptions

and also fails to consider the systematic nature of the selection process.

According to contemporary views, measurement accuracy and predictive efficiency are conditions that merely set the stage for the decision problem. Decision theory recognises that the outcomes of predictors are of primary importance and the measurement and prediction are technical components of a system designed to make decisions about the assignment of individuals to tasks and treatments (Cascio, 1991:279). Furthermore, the decision theory forces the decision-maker to consider the usefulness of alternative selection strategies (Cascio, 1991:306).

Within this framework, Cascio (1991:298-303) suggests that the Taylor-Russel, Naylor-Shine and Brogden-Cronbach-Gleser utility models can provide useful planning information to help selectors make better informed decisions.

3.6.1 The Taylor-Russel utility model

Cascio (1991:298) states that if a new predictor is added to a selection programme, the validity referred to by the Taylor-Russel model is based on present employees who have been screened by any other method than the proposed selection procedure. This approach also assumes fixed treatment selection, where individuals are chosen for specific treatments or course of action, rejected individuals are ignored and accepted individuals are divided into successful and unsuccessful categories.

The major shortcoming of this approach, according to Cascio (1991:298), is that the goodness of a predictor is reflected only in terms of the success ratio. Dichotomous classification (successful/unsuccessful) is used to describe criterion performance, and when validity is fixed, success ratio increases as selection ratio decreases. Furthermore, under these circumstances, the success ratio gives an indication that

more people are successful, but not how much more successful.

3.6.2 The Naylor-Shine model

This approach assumes a linear relationship between validity and utility which holds at all selection ratios. "...given any arbitrarily defined cutoff on a selection measure, the higher the validity, the greater the increase in average criterion score for the selected group over that observed for the total group" (Cascio, 1991:299).

Therefore the Naylor-Shine model of utility is defined by the increase in average criterion score to be expected from the use of a selection measure with a given validity and selection ratio. The assumption is that the new predictor will be added to the current selection battery and that under these circumstances the validity should be based on the concurrent validity model (Cascio, 1991:299).

This model seems, according to Cascio (1991:299), more applicable than the Taylor-Russel index, because, in many cases, if the selection procedure is valid, an increase in average criterion performance would be expected as the organisation becomes more selective in deciding whom to accept.

3.6.3 The Brogden-Cronbach-Gleser model

According to this model, the effects of the validity coefficient, selection ratio, cost of selection and variability in criterion scores on the utility of fixed treatment selection can be determined. Cascio (1991:300) states that the only assumption necessary to use this model is that the relationship between test scores and task performance is linear, that is, the higher the test score, the higher the task performance and vice versa.

The major strength of this model is that the monetary payoff of selection procedures can be calculated.

3.7 Conclusion

As this study deals with the development of a selection procedure, the application of Roe's design cycle to performance predictor models, as done by Greuter (1989:183), is of specific relevance. Furthermore, the ensuring of fairness in the suggested selection model is equally important and therefore the most effective combination of selection variables should be found in order to make the most accurate decisions possible. In order to measure the said effectiveness, it is important to set valid and reliable criteria by which predicted performance can be evaluated.

The criteria set for the evaluation of the predictive validity of the selection variables will be discussed in Chapter 5.