AN EXAMINATION OF THE ROLE OF SCIENTISTS MOTIVATIONS AND THE INFLUENCE OF THE ORGANISATIONAL ENVIRONMENT ON SCIENTIFIC RESEARCH EFFECTIVENESS

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Dissertation submitted in fulfilment of the requirements for the degree of Doctor of Philosophy under the supervision of Professor J Hurley,

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July 2004

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of the degree of PhD, is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my own work

Signed *James C Ryan*

Dated 20/10/04

ACKNOWLEDGEMENTS

Many thanks are due to my friend and mentor Professor John Hurley, his enthusiasm, expertise, encouragement, and support throughout this processes have been unquestionable Thank you John I would also like to thank all my colleagues at Dublin City University and in particular Dr Finian Buckley for his astute comments during the many reviews of this work Many thanks to my fellow postgraduate students, the old crew of Q107, and in particular Mr John Hogan for his support and assistance, following my appointment to AUT I would also like to thank the staff of Dublin City University Library, who did an excellent job of tracking down some quite obscure and hard to find material on the organisation of science I also wish to thank all my colleagues at AUT for their support Sincerest thanks are also offered to the Irish Research Council for the Humanities and Social Sciences for their generous financial support This study would not have been possible without the support and participation of the scientists under examination Their support is gratefully acknowledged

Finally I wish to thank all my friends, who kept me sane and rooted in reality during this process, and my parents and siblings for their continuous encouragement

This work is dedicated to my darling Jennie for her patience, support and love

LIST OF ABBREVIATED TERMS

GNP	Gross National Product
HERO	Higher Education and Research Opportunities
ICSOPRU	International Comparative Study on the Organisation and Performance of Research Units
MMP	Measure of Motivational Provisions
MMS	Measure of Motivational Sources
MSI	Motivational Source Inventory
OCS	Organisational Culture Survey
RAE	Research Assessment Exercise
SERPP	Self-evaluation of Research Profile and Performance

ABSTRACT

This study examines the influence of scientists motivations and the organisational environment in which they work, on scientific research effectiveness The study presents relevant literature on existing perspectives of scientific effectiveness as well as literature on the organisation of scientific research and motivation theory Building on existing literature in these areas a new model of scientific effectiveness is presented that attempts to explain scientific effectiveness through the interaction of scientists motivations and the organisational environment in which they work The study describes the selection and development of new measurement instruments used to operationalise the variables contained within this model Results of data collected from 330 research active scientists in 20 UK universities are analysed Results are discussed in relation to the model under examination, and the new measurement instruments developed during the course of the study Limitations of the current study are presented and recommendations for future research are made

CHAPTER ONE

THE NATURE AND SCALE OF SCIENTIFIC RESEARCH

1 1 The importance of science

The origins of the scientific tradition can be traced back to the ancient Greek philosophers of nature such as Thales (circa 600 B C) who was founder of the Ionian school of Greek thinkers However it is reasonable to say that modern science did not flourish until the seventeenth century, with the rise of the new physics and the works of Galileo, Kepler and later the advances of Newtonian mechanics Indeed the methodological and procedural refinements of modern science since the seventeenth century have contributed greatly to the almost exponential development and advancement of human knowledge in all scientific disciplines since then

Apart from the basic measures of knowledge creation, in the form of publications or patents, the fruits of scientific research have also had a significant influence on the human condition This is particularly true in the western world Increased wealth, improved education, declining infant mortality, greater mobility, advances in social order and equality, and longevity can all be attributed to a greater or lesser degree to the products of scientific research, and its application Science has humanised society It has offered us insight into issues and phenomena that where hitherto clouded by superstition and ignorance

Of course there are concerns expressed about the potentially negative consequences of certain scientific discoveries The potential misuse of our understanding of nuclear

fission is an obvious example Indeed humanities apparent obsession with the application of scientific knowledge to weapons construction is a cause of concern Less immediate threats include increased pollution and the potential misuse of information arising from the mapping of the human genome While scientific advances may create these new threats to humanity, continuing scientific research helps us to overcome them, leading to, perhaps the unsteady but gradually continuing betterment of the human race

In this context scientific research can be viewed as a fundamental component of the medical, technological, environmental, and social advancement of the human race As stated by Perutz (1991)

> science has changed our attitudes towards human behaviour, gradually substituting reason for cruelty, prejudice, and superstition This approach has grown slowly and needs to be preached anew to every generation Otherwise, it is only people's bodies that are jet-propelled while their minds revert to the middle ages (p 4)

All around us we see the fruits of our labour of research The everyday objects we take for granted such as cars, computer processors and the injection moulded cases that house them, modern textiles, processed foods, etc have all been influenced to a greater or lesser degree by scientific research of a basic or applied nature Yet despite the obvious influence and importance of science, little effort has been spent on understanding the conditions best suited to its continuing success, and the characteristics of the organisational environment in which effective research takes place (Hurley, 1997)

1 2 The scale of scientific research

The important role of scientific research in society, as mentioned previously, is further reflected in the scale to which human and financial resources are allocated to it Presented here are relevant statistics regarding the scale of scientific research in the US, Germany, and Ireland, collated by the United Nations, Educational, Scientific and Cultural Organization, (UNESCO) (Unesco, 1999, 2003)

Statistics from the US are presented due to America's recognised position as a leader in many fields of scientific research Statistics from Germany are presented as an example of scientific spending in a large industrialised European nation, and statistics from Ireland are presented to allow for a more localised perspective of resource allocation to scientific research in this country

Table 1 1 The scale of human and financial resource allocation to scientific research in the US, Germany and Ireland (Unesco, 2003)

COUNTRY	YEAR	R&D PERSONNEL PER MILLION INHABITANTS	EXPENDITURE ON SCIENTIFIC RESEARCH AS PERCENTAGE OF GROSS NATIONAL PRODUCT (GNP)
United States	1980	2859	2 32
	1997	4099	2 58
Germany	1981	1596	2 30
	1995	2831	2 41
	2001	3153	2 50
Ireland	1981	1176	0 74
	1996	1873	1 32
	1999	2190	1 23

In the case of the United States the most current data for individual researchers per million inhabitants represents a figure of approximately 1 million people dedicated to the advancement of scientific research This figure includes researchers, technicians

and support staff The scale of scientific research is further highlighted when we consider that a gross national product (GNP) expenditure of 2 58% represents an actual figure of US$2 12 billion, excluding most capital expenditure (Unesco, 2003)

Statistics on resources dedicated to research in Ireland are notably smaller However given the size of the country, its population, and economic history, these figures still represent a substantial amount of both financial and human resources dedicated to the advancement of scientific research in this country

The statistics in table 1 1 highlight another important aspect of scientific research That is, it is expanding Representative figures from the early eighties to the mid nineties and beyond show a marked increase m both the percentage of GNP being dedicated to scientific research and also in the numbers of individuals engaged in this endeavour In Irelands case we see a decline in percentage GDP from 1996 to 1999 However as actual GDP increased in Ireland over this time period the funds dedicated to research and development in Ireland over this period still increased in real terms

Given then, the considerable resources allocated to scientific research its important social and economic role, it is crucial that we understand what makes for scientific effectiveness By appropriately identifying the conditions and circumstances that relate to and facilitate effective research we are better served to ensure the proper allocation of our resources This in turn increases our chances of making new discoveries and developing worthwhile, useful technologies

1 3 What is 'Scientific Research'?

For the purposes of this paper it is necessary to identify specifically what we mean when we refer to scientific research In common use the term scientific research is used to describe a spectrum encompassing everything from the work of the discovery orientated scientist, attempting to enlighten us to the natural complexities of the universe, to the research technician laboriously running repetitive clinical trials Clearly if we wish to investigate, in any way, the effectiveness of scientific research it is necessary to more clearly identify what 'type' of research we are interested in

Using a categorisation developed by Wilts (2000) research institutes can be classified under three headings *Service Providers*, *Research Contractors* and *Knowledge Seekers* As described by Wilts (2000) service providers are institutions that typically lack autonomy These organisations may take the form of research and development divisions in industry, or in-house research divisions in government bodies These service providers depend strongly on funding from their principles, the parent organisation to which they belong Essentially this results in their objectives and goals being directly determined by the influence that external forces have on their internal decision-making process This, in turn, leaves internal members with little control over the subject matter and direction that their research takes

Research contractors are institutions that can be acknowledged as being autonomous, yet depend on the successful marketing of their research results for gaining access to required resources These research organisations could be considered independent or at least semi-autonomous, application-orientated institutes These organisations have

structures in place to insure the adequate management and planning of their research efforts towards their organisational goals And it is through these structures that external clients and organisational stakeholders can directly and indirectly influence the direction of research in this type of institute

Finally, knowledge seekers are constitutionally independent institutes with guaranteed access to specific resources This structure allows internal decision-makers the independence to identify organisational goals and objectives, and modify those goals and objectives at will Due to their autonomy there is little influence from external forces on the internal decision making process of these organisations This provides a level of decision making freedom that could not exist in either the service provider or the research contractor type institutes In essence knowledge seekers are the most independent in determining the research areas they are to focus on, and the way in which their research is conducted

These categorisations are important because they relate the nature of scientific research conducted in an organisation with its source of funding Organisations requiring external sources of funding from private enterprise tend to focus more on application and development orientated scientific research because that is what their 'clients' require However, research organisations that operate with a guaranteed source of funding (usually provided by the public or non-profit sector), do not have the same client concerns and therefore have a greater degree of freedom to pursue basic or discovery orientated research goals

While the categorisations of service providers, research contractors, and knowledge seekers are useful at a broad level, examinations of specific research organisations highlights the fact that an organisation cannot always be clearly positioned within one of these categories Continuing changes in funding structures and research evaluation measures has resulted in some blurring of these distinctions

The statistics presented in table 1 2 reflect the level of funding by both the private and public sector in scientific research They also highlight the increased percentage of research funding from private business enterprise from the early eighties through the early nineties to more recent times This trend is common in most industrialised nations of the western world

Table 1 2 The sources of funding for scientific research (Unesco, 2003)

COUNTRY	YEAR	PERCENTAGE OF FUNDS FROM BUSINESS ENTERPRISE	PERCENTAGE OF FUNDS FROM GOVERNMENT
United States	1980	47 6	46 5
	1995	59 4	35 5
	2002	66 2	28 7
Germany	1980	Unavailable	Unavailable
	1993	61 4	36 7
	2001	66 0	31 5
Ireland	1981	34 3	51 7
	1993	63 4	27 8
	2000	66 0	22 6

The importance of these statistics relates to the changing nature of the focus of scientific research from the basic to the applied As the proportion of private sector funding increases and public sector funding decreases, so too does the proportion of applied research increase as basic research decreases

It is natural that as private business enterprise funding for scientific research increases, so too does the proportion of application and development oriented

scientific research, and concerns over its effectiveness Private enterprise is, after all, concerned with profitability and continuing corporate success Hence it is primarily motivated to fund scientific research that has the potential to enhance its profitability and success in the short to medium term with research findings that are application oriented

The increased proportion of private industry funds for scientific research also serves to blur the distinctions between the afore mentioned categories of Service Providers, Research Contractors and Knowledge Seekers Increasingly, university research departments are contesting for external research contracts and funds Private companies, housed in university campuses, are being formed as 'spin-offs' from university based research findings Private multinationals are providing capital and resource funding for hitherto autonomous research organisations, in return for collaborative links and knowledge sharing All these trends contribute to the evolution of the research institute and influence the focus and approach of modern research

The increased proportion of funding from private busmess also brings with it a change in the nature of scientific research, and new concerns over productivity, efficiency and performance With growing amounts of resources being allocated to applied research, there is a greater concern over their effective use Concerns that are reflected by the increase in journals and research articles dedicated to the topic Many research articles concerned with scientific effectiveness can be found in Journals such as R&D Management, Research Policy, Scientometrics and IEEE Transaction on Engineering Management However the majority of these articles focus on the effectiveness of applied research, as opposed to basic research This is most likely due to the industrial

focus on applied research and the more immediate potential for financial rewards derived from applied research This in turn drives investigation in this area of research effectiveness, so as to ensure future profitability for the corporate sector of industrialised nations

As a result of the unbalanced attention directed towards the effectiveness of applied research and development much less is known about the conditions relating to the effectiveness of basic scientific research Despite this inequality, there is evidence to suggest that many of the concerns and influences affecting the performance and effectiveness of applied research are similar to those affecting the performance and effectiveness of basic scientific research Seminal works on the organisation of scientific effectiveness has either examined industrial research and development exclusively or combined basic and applied research facilities in their analysis (Pelz & Andrews, 1976, Unesco, 1979) Few researchers such as Hurley (1997) have attempted to examine the organisational dimension of basic scientific research and its role in scientific discovery

1 4 The 'Scientific Research' examined in the current study

There are obvious and notable differences between the nature and characteristics of the resources, personnel, methods, management and outcomes of the two ends of the research spectrum from basic to applied For this reason it is inappropriate to view them under the common heading of scientific research This is not to say that one is more or less valuable, as both the discovery and refinement and application of new knowledge is necessary for it to be beneficial to humanity The current study however focuses more specifically on scientific research of a basic nature That is research

directed towards discovery, and the creation of new knowledge, as distinct from applied research that is directed more towards the development and application of existing knowledge

The logic and reasoning behind this decision is simple In a chronological analysis of scientific advancement the discovery must, by necessity, come before the application and development of new knowledge Therefore the discovery, or new knowledge creation is of primary importance, for without it, development and refinement cannot occur Furthermore, previously mentioned investigations into the nature and organisation of scientific effectiveness have tended to focus on this latter form of scientific research Much of the time dedicated to the study of scientific effectiveness has concentrated on the better understanding of scientists and organisations involved in applied research and development, rather than basic scientific research Therefore more research on the effectiveness of basic scientific research is required

This leads us back to our original statement and heading for this section the 'scientific research' examined in this study In the current study scientific research refers primarily to research conducted in organisations classified by Wilts (2000) as knowledge seekers That is, research concerned with the production and creation of new knowledge As stated earlier the distinction between these types of research organisations is becoming increasingly difficult to ascertain However for the purposes of the current study, the research organisations under examination are university based research departments that are relatively autonomous in their decision making processes This type of research organisation allows the scientists working

within them reasonable latitude in the selection and approach to their fields of research

1 5 Aim of the current study

The current study aims to increase our understanding of the effectiveness of 'scientific research' It will do this by examining the organisational environment of several research departments in the chemical and biological sciences from a number of UK Universities It will also examine the motivational characteristics of research scientists working in these research organisations, and how the issue of motivation might influence the performance of research scientists

Before addressing this issue, the following chapters present a review of previously researched factors believed to be related to scientific productivity and performance, an examination of historical research on the topic of scientific research performance and the organisational environment of research, a review of literature on work motivation and its potential influence on a scientists research performance and finally the development of a framework and model on which the current study is based

Chapter two places the current study in context by presenting a review of the research areas that have attempted to understand and explain scientific performance to date An edited version of this chapter and elements of chapter three have been published in Hurley's (2003) Scientific Research Effectiveness The organisational dimension (Ryan, 2003)

Chapter three presents and evaluates previous studies investigating the relationship between the research organisation and scientific effectiveness These include various studies investigating the characteristics of the productive research environment as well as different models designed to explain research effectiveness

Chapter four reviews key literature on the role of human motivation in the organisation and its relationship to scientific research This includes research on the relationship and importance of motivation to scientific effectiveness, as well as a review of classic and contemporary motivational theories

Chapter five presents a newly developed framework on which the current study is based which allows for the structured examination of the potential influence of the organisational environment in which scientific research is conducted and the motivational profile of the scientists who conduct it

Chapter six describes the steps involved in the selection and construction of suitable measurement instruments needed to operationalise the concepts examined in the current study

Chapter seven provides a description of the methodological procedures employed in the current study

Chapter eight presents an evaluation of the measurement instruments used in the current study

Chapter nine presents the results of the current study

Chapter ten discusses the results of the current study in relation to existing knowledge in the areas of work motivation and scientific research performance It also highlights the limitations of the current study and makes recommendations for future research in this area

CHAPTER TWO

EXISTING ATTEMPTS TO UNDERSTAND AND EXPLAIN SCIENTIFIC RESEARCH PERFORMANCE

2 1 Introduction

Over the course of the last fifty years psychological and sociological researchers have devoted considerable time and effort to their attempts to understand and explain scientific ability and the psychological make-up of the scientist This research has examined aspects of the scientist's developmental, educational, personal, cognitive and social conditions (Feist & Gorman, 1998), and some of the more consistent findings in these areas are presented here These findings include research in the areas of genetic predisposition, birth order, environment, religion, gender, age, personality and creative ability

2 2 Genetic predisposition to scientific ability

The developmental profile of eminent scientists has been one focus of those interested in exploring the genetic components of scientific effectiveness This research has examined cases of precocious mathematical and reasoning ability Historical figures such as Pascal, Newton, Leibniz, Gauss and Boole are just some of the eminent scientific thinkers who are known to have had very advanced mathematical abilities at a young age (Bell, 1937) The accounts for such abilities have typically been subjected to the nature-nurture argument That is, are such abilities a result of social and environmental influences or are they genetically determined Interestingly many

of the eminent individuals listed above are documented as coming from rather humble and non-mathematical backgrounds

The genetic predisposition towards scientific ability can be explained by Lykken's principle of emergenesis, which accounts for the hereditary transmission of traits that don't appear to run in families There is also evidence from twin studies that non-genius mathematical ability may, at least partially, be genetically determined (Lykken, McGue, Tellegen, & Bouchard, 1992, Vandenberg, 1988) Such research suggests that the likelihood of scientists being successful in their chosen field may be at least partially determined by their genetic makeup However the argument as to whether scientific and particularly mathematical ability is genetic or a result of environmental factors is still continuing

In recent years this line of investigation has taken a new twist with the mapping of the human genome and the attempts by genetic researchers to identify those singular or sets of genes that relate to specific human traits or abilities At present much controversy surrounds this research with fears over the possible misuse of information relating to an individuals genetic susceptibility to particular traits and behaviours, as well as medical conditions and disorders While our genetic make-up undoubtedly plays an important role in human development, we can only wait to see if research in this area can offer us a detailed and useful insight into the development of scientific ability

If such a time arrives that the genetic bases for scientific ability is clearly identified, current thinking on the interaction of heredity and environment on the issue of

intellectual ability suggests that there is still a real need to understand the overlying environment in which the scientist lives and works Researchers such as Scarr (1991) have championed the hypothesis that heredity sets certain limits, known as the reaction range, on our intellectual abilities, but that it is environmental factors that determine where individuals fall within these limits In simple terms our genetic disposition may provide us with a certain potential, but the degree to which that potential is realised may depend largely on the environment in which we develop

2 3 Birth order and later scientific achievement

Research into the links between the development of the scientist and their family background has examined the relationship between birth order and scientific eminence Some research suggests that creative scientists are more likely to be first born than non-creative scientists (Helson & Crutchfield, 1970) Despite these studies being criticised as inconsistent and inconclusive (Ernst & Angst, 1983, Falbo & Polit, 1986) a large study by Sulloway (1996) found a curvilinear relationship, between birth order and eminence

Of his sample of scientists, first and last-born scientists were generally found to be more successful in their fields than 'middle' children Adlerian explanations for such relationships point to the differing experiences and expectations of children within their familial and social environments as a consequence of their birth order For example, the oldest child m a family is often given responsibility and expected to set an example, additionally their parent's expectations are usually very high They are more likely to be responsible, ambitions, determined, and achievement orientated These children are then more likely to become high achievers, have greatest

educational and academic success, and be determined and responsible Youngest children, as a result of their differing experiences within the familial environment are more likely to be creative, risk-takmg and questioning of authority (Sulloway, 1996)

These differences are believed to significantly influence an individual's personality development and consequently the decisions and directions they choose to take with their lives as adults It is reasonable to suggest that personal characteristics such as ambition, determination and achievement, as well as creativity, risk-taking and questioning of authority are traits that are likely to be advantageous if pursuing a career in science

2 4 The influence of the family and social environment on success in science

Further examinations of the developmental background of scientists have also examined aspects of the family and educational environment Werts and Watley (1972) demonstrated that the family environment can exert a strong influence on the choice of science as a career The role of the mentor in later life is also important In the case of high performing scientists, it seems that having an eminent mentor also appears to be a contributing factor in obtaining eminence (John-Steiner, 1985, Simonton, 1992, Zuckerman, 1977)

The advantages of training under an eminent scientist are many Those scientists trained under Nobel Prize winners are more productive at an early stage in their career and are more likely to produce works of significant impact in their chosen field They are also more likely to win a Nobel Prize themselves Researchers such as Berry (1981), Feist (1991), and Zuckerman (1977) have shown that professional scientists

are far more likely to come from families of professional occupations and higher education

Apart from any interpersonal influences a parent in a scientific profession may have on their child, we must also consider the greater financial support and educational opportunities available to those whose parents are working professionals In countries where education is the privilege of those who can afford it, socio-economic background plays a fundamentally important part in determining the probability of an individual's pursuit of a scientific career This is not simply an issue as to whether a certain educational level can be attained, but also the quality of that education

Longitudinal retention data on finalists of the Westinghouse Science Talent Search found that after only five years, more than 30% of the sample was no longer engaged in scientific careers Lack of financial support, and lack of stimulating and motivating school and college mentors were among the strongest discriminators between those who dropped out and those who continued in science (Subotnik, Duschl, & Selmon, 1993, Subotnik & Steiner, 1992)

2 5 Religious family background

The influence of religious family background on the developing individual may also have a significant effect on future scientific performance Some estimates suggest that 20% to 30% of the most creative and elite groups of scientists come from Jewish backgrounds (Chambers, 1964, Datta, 1967, Zuckerman, 1977) It is important to note that these figures refer to the religious family background and upbringing, not to the

current religious practices of the scientists Studies that have looked at the current religious practises of scientists have found an almost complete absence in religious faith (Chambers, 1965, Roe, 1952)

Berry (1999) examined the relative productiveness of western religious traditions by regression analysis on a data-base of nearly 1,400 notable nineteenth and twentieth century achievers in six science-related and three arts domains Results showed that Protestant fractions were more productive in all sciences than more dogmatic based religions such as Catholicism, and that Jewish fractions showed the highest incidence of creativity

Also of interest was Berry's (1999) finding that there were no reduction in these differences over time Whatever hidden cultural roots are influencing these trends seems to have been maintained across this time period Explanation for such findings may be socio-economic Historically in the industrialised world there has been a link between religious background and economic position in society, with more individuals from Jewish and Protestant backgrounds occupying the higher rungs on the socio-economic ladder This superior economic positioning can also be associated with an increased availability of education and training The increased ability of individuals from these religious backgrounds to attain a high level of education may account for their overrepresentation in certain professional fields

2 6 Gender and scientific achievement

Gender differences have been a source of psychological study for decades with a resultant mass of literature being produced Differences in mathematical ability are

among some of the more consistent findings in the gender difference literature with males showing consistently higher scores than females across a distribution of scores (Benbow, 1988; Maccoby & Jacklin, 1974). However, although differences still exist, a trend is emerging in the literature suggesting that the gender gap among all cognitive differences has diminished over the last two decades (MacIntyre, 1997).

On the issue of gender and scientific productivity, comparing the publication rates of male and female scientists consistently show that males produce more than females. This difference appears to hold for total number of publications and yearly averages (J. R. Cole, 1987). However, while Cole (1987) reports that this gender difference increases over the course of a career, Long (1992) found that it decreases over the course of one's career. If we are to use citation counts as the measure of scientific impact then men receive more citations than women. However once the number of publications is held constant women seem to produce works of greater impact than men (Long, 1992; Sonnert, 1995).

Despite the large body of work on gender differences in science, findings in this area seem weak and incomplete. If anything there seems to be a very small bias towards males in science, but the importance of this bias on a global scale is questionable.

2.7 Age and productivity in science

While debate on the extent of gender differences in scientific performance continues with little agreement, the issue of whether age affects scientific performance seems to have some conclusion. Almost all studies conducted on the relationship between age and productivity have shown a curvilinear relationship that peaks in the late thirties or

early forties and drops off more gradually than it rose In general terms there appears to be an inverted U relationship between age and productivity in science and other professions (Simonton, 1988a) While the relationship is clear, and consistent, it is also weak Horner, Rushton and Vernon (1986) found that age accounted for only 6 5% of the variance in relation to scientific productivity

This weakness in the relationship between age and productivity requires a more detailed theoretical approach to the topic Such an approach has been taken by Simonton (1988b) who explains the relationship between age and productivity in terms of factors that he classifies as either intrinsic or extrinsic to the process of scientific achievement Extrinsic factors may include decline in physical health, increased administrative and teaching obligations, and unfavourable working conditions Intrinsic factors include changes in motivation, creativity, intelligence and experience Little empirical work has been carried out on intrinsic changes with age, but Schaie (1984) points to a late and small decline in intelligence with age A longitudinal study by Eiduson (1974) also reported a decline in scientist's drive, with age

Simonton (1984, 1988a, 1988b, 1989, 1991) has developed a more complex theoretical model which attempts to explain the age-productivity relationship by focusing on intrinsic cognitive components The theory consists of several key components Firstly, each 'creator' starts off with a set amount of creative potential Secondly the realisation of this creative potential is broken into two components, ideation and elaboration Ideation is that rate at which potential ideas are expressed while elaboration is the rate at which ideas are put into concrete form

As each 'creator' produces a new work they expend some of this creative potential So the rate at which a 'creator' realises their potential is a function of the two cognitive transformations, namely ideation and elaboration The creative output peaks approximately 20 years into the 'creator's' career and then slowly declines This interesting theoretical approach shows promise in explaining the age productivity relationship

Apart from variations in productivity across the life span there also appears to be a relationship between early levels of productivity and future performance Early levels of high productivity do tend to predict continued levels of high productivity Research suggests that the most prolific scientists, out-publish their medium and low counterparts by two to one in the 25 to 34 age group, and maintain a paper per year advantage over others until their mid sixties or seventies (Horner et al , 1986) This imbalance in productivity may be due in some small part to the phenomenon of cumulative advantage The theory of cumulative advantage states that those who publish frequently in their early careers are rewarded by their peers and continue to receive more and more recognition, financial support and social support Consequently they continue to produce more (S Cole, 1979) There is also some evidence that quantity of publications matters more than quality of publications when predicting who will receive the most peer recognition and reward honours (Feist, 1997)

A further productivity imbalance was examined by Over (1989) when examining whether older scientists were more likely to produce works of lower quality than

younger scientists He found that although a disproportionate number of high quality works come from young scientists, young scientists produced an equally disproportionate number of low quality works This suggests that the large number of high quality works was not produced because of age, but simply because of the high number of young scientists

The issue of age and productivity is an important one, as a relationship between age and productivity, if not quality, does seem to exist If the relationship is as consistent as studies suggest then this should be recognised and controlled for by researchers, so as to clearly separate organisational influence on productivity, from the existing influence of age on productivity

2 8 The scientific personality and research performance

Research on the personality of the scientist has yielded generally consistent results A review of the empirical literature on personality over the last forty years reveals the consistent characteristics of the scientific personality Scientists can be typically described as achievement orientated, conscientious, dominant, driven, emotionally stable, impulse controlled, independent, and introverted, with more eminent and productive scientists scoring higher on many of these factors than their less eminent colleagues (Feist & Gorman, 1998)

Despite the relatively consistent results found in this area of research, the relationship between the scientist's personality and scientific research effectiveness is not completely clear Simonton's (1988a) examination of age and scientific productivity

points to changes in intrinsic variables such as motivation which may be dependent on personality characteristics such as drive and ambition As personality changes so productivity may be affected The major shortcoming of personality study is the lack of longitudinal research into personality change and stability To what degree do an individual's personality characteristics determine their career choice and productivity in a scientific domain and to what degree does a career in science influence the personality characteristics of the individual? Unfortunately these are questions that as yet have no answer Modern approaches to personality development propose the perspective that personality traits exhibit considerable continuity over time, yet can change in systematic ways (Robins, Fraley, Roberts, & Trzesniewski, 2001)

2 9 Creative ability and science

Attempts to link creativity with scientific performance have been examined by Amabile (1983, 1988, 1994) who proposes that 'the ultimate driving force behind all of scientific progress' is human creativity (1994, p316) Although considerable research has been conducted in the area of creativity in science, much of this has been conducted in psychological laboratories with students of science rather than actual scientists Consequently the relationship between creativity and real world scientific productivity is still unclear While Amabile's 'Componential Model of Creativity' offers a useful insight into creative thought, further work is needed to establish the actual frequency and importance of creativity in real world scientific research A more detailed explanation of the Componential Model of Creativity is provided in chapter three, section 3 2

2 10 Understanding the personal components of the scientist

To aid our understanding of what makes for an effective scientist we can illustrate the contribution of various psychological and personal components to the formation of the scientist as an individual Figure 2 1 represents these components as inputs, which contribute to the likelihood of success in a scientific domain In all cases the factors presented in figure 2 1 have been shown to have some reasonable empirical and/or theoretical support for their relationship to scientific performance What will be evident to those readers interested in the manipulation and improvement of scientific effectiveness is the personal and in some cases unchangeable nature of the factors included in the illustration

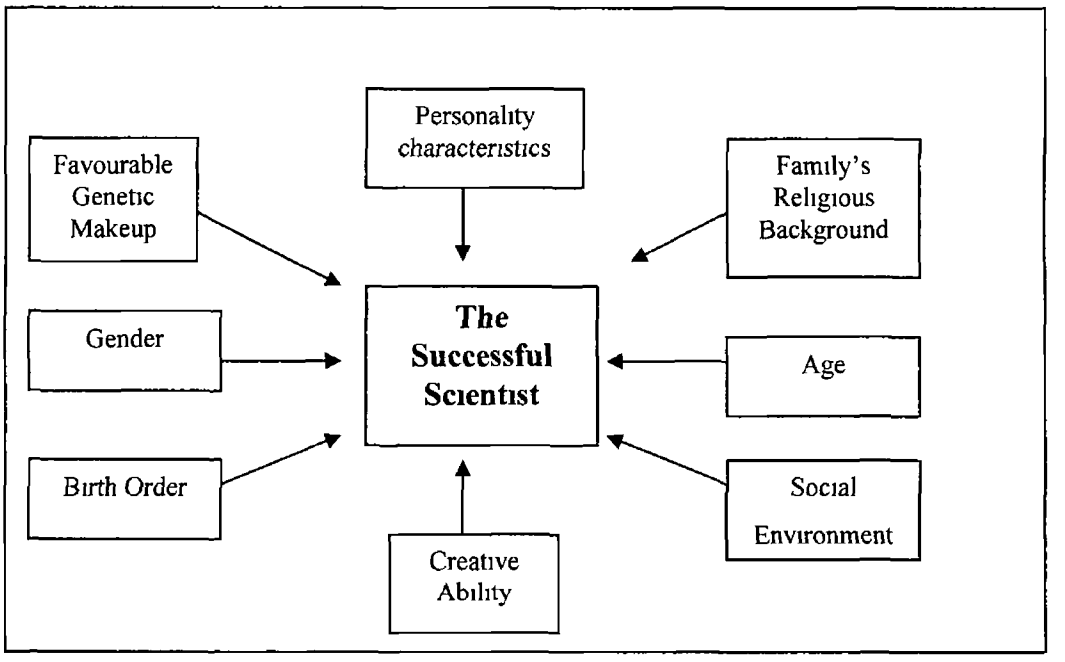


Figure 2 1 Factors presented as influential in the likelihood of an individual becoming an effective scientist

For those concerned with the practical problem of improving scientific effectiveness, the variables presented in figure 2 1 provide little scope for change or manipulation External parties cannot influence factors such as birth order, genetic makeup, family's religious background, gender, age, and the profession of the scientist's parents

Further research is also required on the role and influence of the scientific personality and also on creativity in science before we can use our knowledge of these factors to influence and improve scientific effectiveness In practical terms we have a body of knowledge about a group of factors that are believed to be correlated with a scientist's future levels of performance, but with no clear method of manipulating these variables to improve scientific effectiveness

Consequently, if we are interested in improving scientific performance today, we need to move away from research that attempts to link factors in a scientist's biographical and developmental history with present scientific performance Instead we should move towards research that examines the actual environments in which scientists work and how these environmental factors interact with the personal characteristics of the scientist to influence research performance

CHAPTER THREE

MODELLING SCIENTIFIC EFFECTIVENESS THE IMPACT OF THE ORGANISATIONAL ENVIRONMENT ON RESEARCH SCIENTISTS

3 1 Introduction The organisational environment of scientific research

As presented in chapter two a large body of research exists on the nature of scientific productivity and performance However, the majority of this work has focused on identifying individual characteristics that may act as predictors of a scientist's likely success in their field In contrast chapter three moves away from the focus on the individual and examines some of the key theoretical explanations of research effectiveness that take into account the important role of the environment in which research takes place

The following section provides a summary of the key research findings on the influence of the research environment on scientific performance, this is followed by an evaluation of various models of research effectiveness

Before continuing it is important to highlight the various guises under which scientific performance is presented m the literature The concept of scientific progress is not a simple one, terms such as effectiveness, innovation, creativity, productivity, and discovery, all allude to a general concept of scientific performance Despite differences in the theoretical or methodological approaches of researchers in different areas what is common among these terms is that they all refer to some measurable

output resulting from engagement in scientific research For the purpose of this review and summary of key research in the area of organisation/environment and scientific performance, the words 'performance' and 'effectiveness' are used as general terms to describe some measurable output resulting from scientific research, be it productivity, discovery, innovation, etc

Table 3 1 highlights the key contributions over the last fifty years in the field of the influence of the work environments or organisation of scientific research on research performance

Table 3 1 Key research relating to the organisational environment and scientific performance

YEAR	AUTHOR	TOPIC
1956	Baumgartel, H	Leadership, Motivation, and Attitudes in Research Laboratories
1967	Andrews, F M	Creative Ability, The Laboratory Environment and Scientific Performance
1968	Argyris, C	On the Effectiveness of Research and Development Organizations
1971	Glueck, W & Thorpe, C	The Management of Scientific Research
1976	Pelz, D C & Andrews, F M	Scientists in Organizations
1979	Unesco	Scientific Productivity The effectiveness of research groups in six countries
1987	Thamhain, H J & Wilemon, D L	Building High Performance engineering Project Teams
1988	Amabile, T M	A model of creativity and innovation in organizations
1992	Bland, C J , & Ruffin, M T	Characteristics of a productive research environment Literature Review
1997	Hurley, J	Organisation and Scientific Discovery
1998	Mouly, V S , & Sankaran, J K	The behaviour of Indian R&D project groups An ethnographic study
1998	Chawla, A & Singh, J P	Organizational Environment and Performance of Research Groups- A Typological Analysis

Research presented in table 3 1 represents key literature specifically directed at investigating and understanding the influence that the organisational environment has on the performance of research scientists A review of the literature on the limited research conducted on the organisational environment of research to date has identified several organisational factors related to the performance of these research units Influential factors include communication, leadership, clear goals, organisational culture, group climate, rewards, recruitment and selection practices, assertive participative governance, and others (Bland & Ruffin, 1992)

Despite the identification of organisational/environmental factors related to performance, theoretical explanations for these relationships are scarce Few attempts have been made to explain why such factors are of importance and how they affect the individual scientist and their performance levels Theoretical models of research performance are few in number and limited in their explanatory ability

3 2 Modelling scientific performance

The following section reviews the few useful attempts that have been made to model the performance of scientists in the research organisation The models presented in this review represent the few attempts that have been made to understand scientific performance within an environmental domain, whether that domain be the laboratory group, the research organisation, or the scientists immediate physical and psychological environment

This section describes and evaluates proposed models of scientific performance The purpose of this is to identify strengths and limitations of these models This is done to aid in the formulation of a new model of scientific research performance, to be tested in the current study in an attempt to advance our understanding of the role the environment has in influencing the performance of scientists

3 2 1 The management of science

One of the earliest attempts to explain the administration of modern science was conducted by Glueck and Thorp (1971) During the course of compiling an annotated bibliography of research on the organisation and administration of scientific research they developed a general model of the management of research

This model is essentially a systems model identifying *inputs* into and *outputs* from the 'Management Research Process' These inputs include such items as funding, financial resources, equipment and supplies, and human resources The outputs represent concepts common to our understanding of research effectiveness, such as new theories, ideas, problem solutions, and inventions

Of primary interest to the current study are the environmental characteristics that Glueck and Thorp (1971) identify within the 'Management Research Process' These environmental characteristics of the organisation include factors such as preparation and planning, organisation/coordination, control/conflict, organisation climate, reward structure, and evaluation

The model is useful in that it recognises the need for suitable organisational characteristics to exist within the management research process It highlights the transformation of inputs (resources, both human and financial) through the research process, into outputs The importance of this work is highlighted in the fact that the environmental characteristics of the research process identified by Glueck and Thorp (1971) are seen to be significant in more recent studies on the organisation of science, which are discussed later in this review However, it should be noted that the model is primarily descriptive It is essentially a systems model that hypothesizes as to the nature of relationships between inputs, the research management process and outputs

The model itself has not been empirically tested nor does it explain the nature of relationships within the research management process Although the model lacks explanatory power it offers a useful starting point for our understanding of the influence that the organisation of science can have on scientific effectiveness

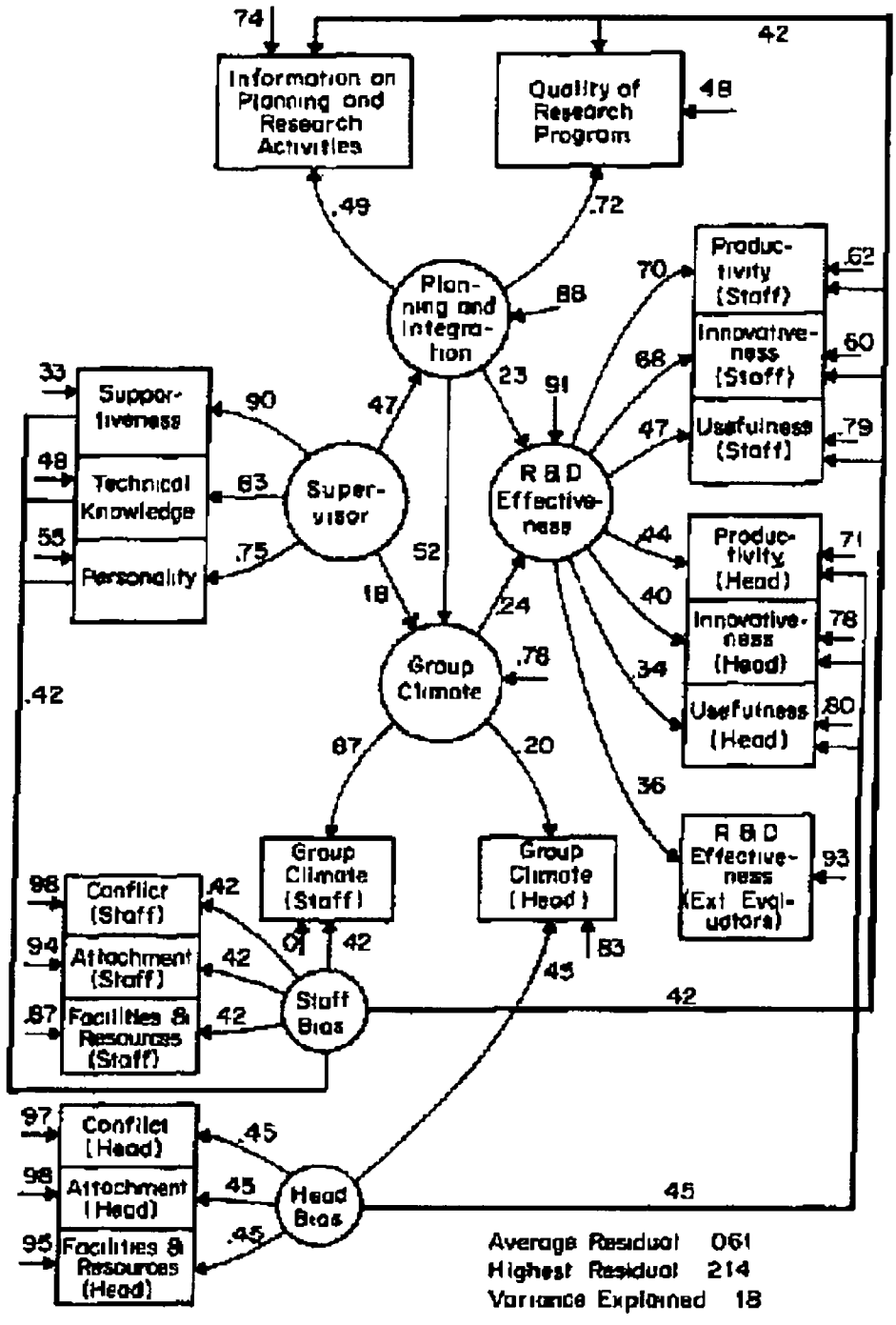
3 2 2 The Unesco study

Unesco (1979) conducted one of the largest ever studies on the organisational environment of science The first round of this 'International Comparative Study on the Organisation and Performance of Research Units' (ICSOPRU) examined the performance-effectiveness of scientific research units in six European countries (Austria, Belgium, Finland, Hungary, Poland, and Sweden) In all 1,222 research units were examined The majority of these institutes were in academic organisation, with the remainder being research units located in co-operative research and development institutes that serve a sector of the production, industry or public service, and units located in research laboratories of productive enterprise

Data from this study was then analysed using structural equation modelling The Lisrel Model of research and development effectiveness constructed from the data collected during the study provides a useful description of the interactions that take place within the research unit

The Lisrel technique used in the Unesco study is a computer program for estimating general linear-structural equation models and also allows for unmeasured hypothetical constructs or 'latent variables' Several models relating to variables such as supervisory position, and supervisory leadership and outcome measures such as publication productivity and research effectiveness were constructed Figure 3 1 represents just one of these models to serve as an explanatory example of the work of the Unesco study

True relationships between latent variables (circles) are represented by linkages between them as path coefficients Linkages between observed variables (rectangles) and latent variables (circles) represent construct validity and are reported as regression coefficients Arrows pointing to observed (rectangles) variables indicate measurement errors, while arrows pointing to latent variables (circles) represent disturbances or residuals



Lisrel model of R & D effectiveness (response bias included) for academic natural science units.

Figure 3 1 Lisrel Model of R&D effectiveness for academic natural science units (Unesco, 1979)

Figure 3 1 expresses the statistical relationships between the observed and latent variables being investigated within the Unesco study However the area of primary interest for the current study is the overall variance in research and development effectiveness accounted for by the model (18%), and the interaction between the latent variables (Supervisor, Planning and Integration, Groups Climate and R&D Effectiveness)

While the variance accounted for by the Lisrel model is quite small (18%), the Unesco (1979) model of research and development effectiveness provides a useful illustration of how various aspects of the research environment interact The Unesco (1979) model is a statistical representation of the relationship between factors identified within the study These relationships express the influence that one or more variables may have on another It does not however have any theoretical bases The Unesco study was not designed to validate a hypothesised model of research effectiveness based on any theoretical proposals Consequently the model is descriptive, identifying statistical relationships between factors, but with no explanatory significance While identifying statistical relationships between factors, the model does nothing to enhance our understanding of the causes or determinants of such relationships This severely limits any potentially practical implications of the study Without any theoretical explanation of relationships within the model, any manipulation of variables by a practitioner interested in improving scientific performance could result in unwanted and unexpected consequences

Despite this weakness the Unesco (1979) study provides the opportunity for ad hoc investigations of theoretical explanations for the relationships identified in the model,

and the factors that were found to significantly impact on scientific performance In doing this it contributes positively to any considerations on the development of a theory of research effectiveness For example figure 3 1 shows that 'Group climate' is strongly related to 'Supervisory Quality' and 'Planning and Integration' A theoretical advancement of such a model might examine the leadership styles or decision making process in use within the research unit and their influence on group climate, or perhaps the motivational processes of the supervisor in determining their orientation towards personal interactions within the research group If we wish to influence the performance of scientists it is insufficient to simply identify a relationship, we must also seek to understand the relationship Such theoretically based studies, building on the relationships identified by the Unesco study would enhance our understanding of scientific effectiveness

In spite of the weaknesses of the Unesco (1979) study it is the largest study of its kind, and given the strength of the statistical procedures employed in the study it offers the most significant and clear evidence of the link between characteristics of the research organisation, and the research productivity of such organisations

3 2 3 Building high performance engineering project teams

Thamhain and Wilemon (1987) developed a systems model of research team performance The primary goal of the study was to present a model that identified the main influences on engineering team performance Performance in this instance was a measure of three separate criteria, technical success, on-time performance, and on budget/within resource performance The study was based on data collected from interviews with 500 engineering professionals, based in high-technology businesses in

the US The systems model presented in figure 3 2 breaks down the complexity of the research unit process, and allows for the understanding of the research teams performance in terms of inputs, influences and outputs, similar to the model proposed by Glueck and Thorp (1971) This approach is useful in that it provides a framework for studying the influences and characteristics of the research unit

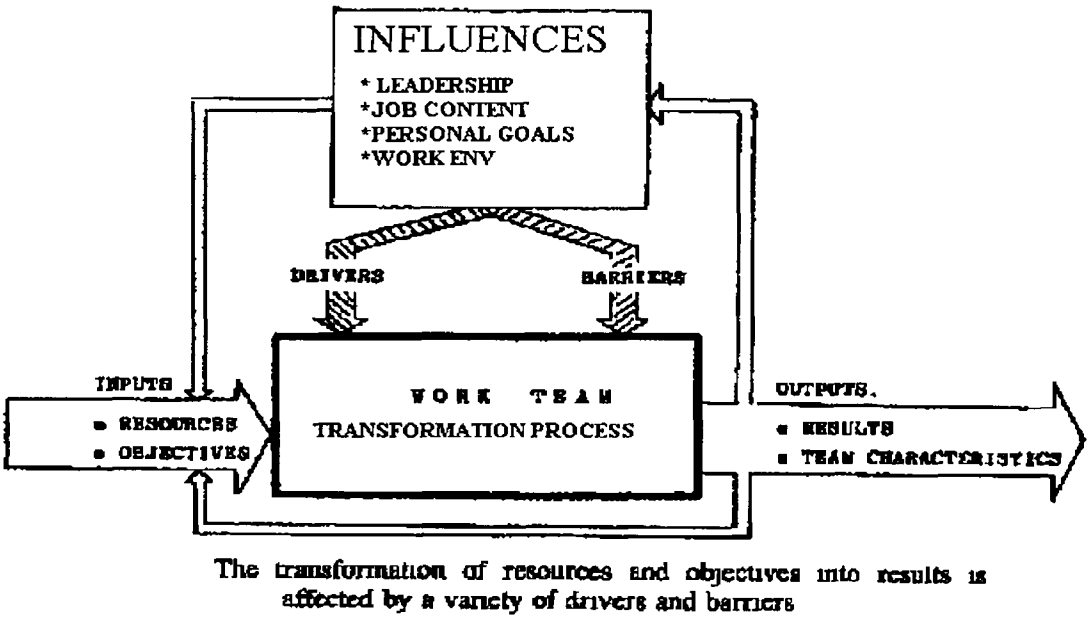


Figure 3 2 The systems model of high performance research teams (Thamhain & Wilemon, 1987)

The model illustrates how resources and objectives are transferred into results and team characteristics through the influence of various drivers and barriers A list of principal drivers and barriers as perceived by project professionals is presented by Thamhain and Wilemon (1987) Drivers include factors such as stimulating work, freedom, communication, good interpersonal relations, and proper planning While barriers include factors such as unclear objectives, conflict, lack of commitment, poor communication, and differing interests

This model represents a useful descriptive representation of the factors affecting project performance The factors identified as performance influencers are similar to those identified in the Unesco (1979) study However the model suffers from the same major weakness as the Unesco (1979) study and earlier work by Glueck and Thorp (1971), in that it is atheoretical While describing the transformation of resources and objectives into results and team characteristics the model offers no theoretical explanation as to why such factors are important and how they influence the transformation process A systems approach is valuable in formulating generalised models of interactions, but offers little insight to specific relationships or interactions between variables, or the reasons behind them Again we are left with a useful description of factors influencing performance, but with little understanding of how or why such factors are important

3 2 4 The creative research environment

Amabile suggests that 'the ultimate driving force behind all of scientific progress' is human creativity (Amabile, 1994) As one of the foremost writers and researchers in the area of creativity Amabile proposes a componential model of scientific creativity By focusing on the effect of social factors on scientists' motivation and on the effect of motivation on creativity, this model recognises the influential nature of the organisational environment

Amabile's (1988) model includes three major components, domain relevant skills, creativity relevant skills and intrinsic task motivation Domain relevant skills are the basic skills required by the scientist to perform adequately in their specialist area This

includes such skills as technical proficiency, and memory for factual knowledge of their field Such skills depend on the scientist's innate cognitive abilities, the level of their formal and informal education, as well as their perceptual and motor skills

Creativity relevant skills refer to more specialised abilities such as cognitive styles favourable to taking new perspectives on problems or issues, and persistent or energetic working styles, also certain personality characteristics such as self-discipline, independence, and tolerance for ambiguity These skills depend on factors such as personality, past experience and training

The final component in Amabile's (1988) model is intrinsic task motivation This is described as 'the motivation to engage in a task primarily for the sake of task engagement- because the activity itself is interesting, enjoyable, or personally challenging to the individual' This component is viewed as the most critical, due to the fact that it can be easily influenced by external factors, and also because if intrinsic motivation is high, then deficiencies in the other two components (domain and creativity relevant skills) can be compensated for to some degree (Amabile, 1994)

The positive interaction of these three components results in a creative output The componential model of creativity offers a useful insight into the creative process and the model aids the practical understanding of a rather abstract process, that of creativity The components of domain and creativity relevant skills highlight some of the personal characteristics and abilities required by scientists in order to perform adequately in their fields Additionally the intrinsic task motivation component

highlights a most interesting and primary factor when examining scientific performance, that of motivation, and the affect the environment may have on the scientist's levels of motivation

Domain-relevant skills	Creativity-relevant skills	Task Motivation
Includes -Knowledge about the domain -Technical skills required Special domain relevant 'talent' *Depends on* -Innate cognitive abilities Innate perceptual and motor skills -Formal and informal education	*Includes* -Appropriate cognitive style -Implicit or explicit knowledge of -heuristics for generating novel ideas -Conductive work style *Depends on* -Training -Experience in idea generation -Personality characteristics	*Includes* -Attitudes towards the task -Perceptions of own motivation for undertaking the task *Depends on* -Initial level of intrinsic motivation -Presence or absence of salient extrinsic constraints in the social environment -Individual ability to cognitively minimize extrinsic constraints

Figure 3 3 The Componential model of individual creativity (Amabile, 1983)

Experimental support for Amabile's work, is generally based on student samples in contrived research settings (Conti, Coon, & Amabile, 1996) This limits its usefulness in explaining scientific performance in the 'real world' of the research laboratory

Amabile's proposal that the 'ultimate driving force behind all of scientific progress' is human creativity remains a hypothesis Certainly throughout a scientist's career it is likely that there are instances that require some form of creative problem identification or solution However the majority of a scientist's time is spent seeking greater clarification about the problems that they face and developing and testing hypotheses arising from these observations In addition to this, considerable time is spent on the day to day activities of running experiments, attending meetings, writing research reports, preparing funding proposals, teaching, and other less attractive chores within the research laboratory The precise role and timing of creativity within this setting is not yet clear

Amabile's research does not clearly locate the position of creativity in the process of scientific performance However if we accept creative output as a proxy for scientific performance then Amabile's research highlights one very interesting relationship related to the current study, that is the relationship between the research environment, the scientist's motivation, and some measurable outcome From this, one can hypothesise that the factor that is of critical importance to the progress of science may not be the motivation to be creative, as Amabile suggests, but rather the motivation to persist, to follow through on the often arduous, meticulous and repetitive work of scientific research

3 2 5 The organisation and scientific discovery

The theoretical model of scientific discovery presented by Hurley (1997) highlights the importance of the suitable combination of organisational variables and individual variables Hurley (1997) investigated the factors influencing the likelihood of scientific discovery Having collected data from a number of Nobel Laureates he proposed a model of scientific discovery, explaining likelihood of discovery in terms of a combination of individual characteristics and organisational characteristics This theoretical model suggests that the suitability of the scientist's ability and personality, coupled with the suitability of the organisations resources and dynamics, determines the likelihood of a discovery taking place Individual characteristics include such factors as motivation, technical ability, persistence, curiosity, etc While organisational characteristics include such factors as equipment, library facilities, communication, freedom, leadership etc Figure 3 4 illustrates the process

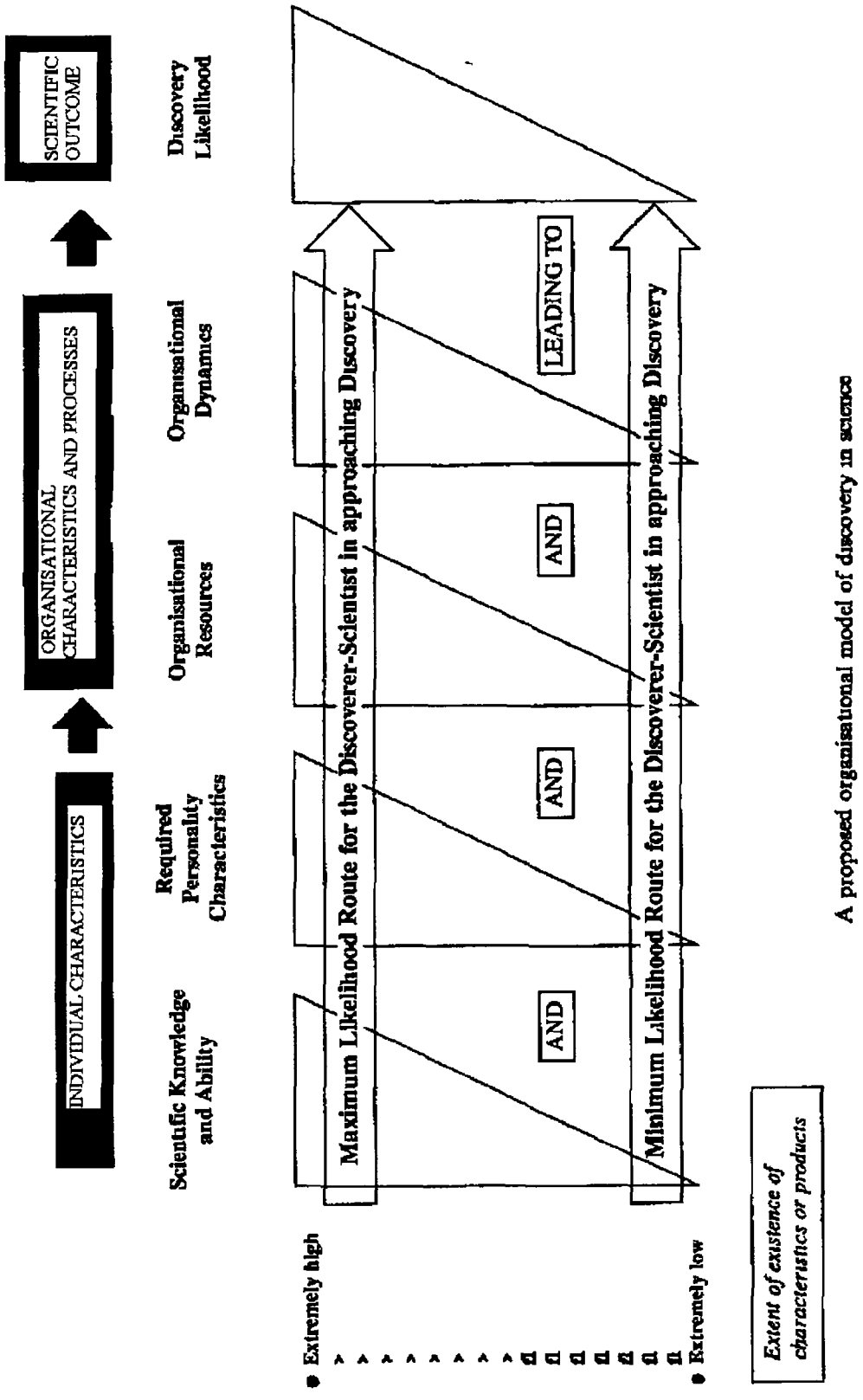


Figure 3 4 A proposed organisational model of discovery in science (Hurley, 1997)

The model advances our understanding of the discovery process and Hurley explains in detail the theoretical process leading to discovery, starting with the selection of the able 'discovery oriented' scientists into the research laboratory and finishing with the eventual scientific discovery Importantly the model highlights two fundamental concepts in our understanding of scientific performance Firstly, the concept of the individual scientists characteristics, and secondly, the concept of the organisations characteristics In Hurley's model it is the optimal combination of these two that results in the discovery Unlike the previous models reviewed Hurley's (1997) model has a strong theoretical base, but is lacking in any empirical support By his own admission the model is 'essentially a speculation on the nature of reality' (Hurley, 1997 p148) Yet despite this weakness the model offers an interesting theoretical perspective on the discovery process, and provides suggestions for future research in the area A most valuable contribution of the model is its identification of the required suitability of both, the organisational environment and the individual scientist

3 3 Direction for future research

Having examined research that relates to the organisational dimension of scientific effectiveness, it is clear that our understanding of the environment in which good scientific research takes place is not complete Several researchers have made considerable progress in identifying many of the organisational characteristics relating to scientific effectiveness, while others have proposed various models of research effectiveness in an attempt to explain the nature of relationships between the organisation and positive scientific outcomes

The current study builds on the research presented in this chapter by developing a testable hypothetical model of research effectiveness, which incorporates many of the propositions and findings of previous researchers in this area, and new theoretical developments in the area of human motivation

Before presenting this model it is necessary to dedicate a chapter specifically to the topic of work motivation, so as to review the major contributions from this field and also to highlight the relevance of the motivational concept to the research organisation and scientific effectiveness

CHAPTER FOUR

MOTIVATION IN ORGANISATIONS A REVIEW OF THE LITERATURE

4 1 Why work motivation is important to the current study

The study of work motivation is important to our understanding of scientific research performance because of the information it provides us about the organisational processes and factors that affect the direction, intensity and persistence of scientist's behaviours Despite the continuing and substantial attention that is paid to the concept of work motivation, little time or effort has been devoted to the study of motivation in the research environment Researchers such as Karle (1990, 1997) have asserted the importance of motivation to scientific performance, as have eminent scientists themselves (Hurley, 1997) Research by Amabile (1994) has highlighted the importance of intrinsic motivation to creative output, and vicariously to scientific performance However few experimental or investigative attempts have been made to systematically examine and explain the role of motivation in influencing scientific performance

Most significantly the concept of motivation is perfectly situated as a bridging variable between our understandings of scientific effectiveness as influenced by individual characteristics and scientific effectiveness as influenced by organisational characteristics Motivation is a psychological phenomenon, an internal state of a person that impels them towards action, and as such is an individual characteristic

However the individuals' ability to satisfy their motivational needs occurs within a specific context or environment, and as such is contingent on organisational characteristics This interaction of individual and organisational characteristics within the construct of work motivation provides a perfect basis from which to enhance our understanding of scientific effectiveness, as a joint individual/organisational outcome

The following section will first review the few studies that have attempted to examine the role of motivation in scientific performance and behaviour Secondly it will present a review of traditional work motivation theory and finally it will present a recently integrated meta-theory of work motivation for use in the current study

4 2 Motivation and the scientist

One of the earliest studies into the nature of motivation in a research environment was carried out by Baumgartel (1956) Baumgartel examined the relationship between the leadership styles of research supervisors and the resulting attitudes and motivation of the research team A questionnaire was administered to all 310 research scientists and leaders in a large medical research organisation Leadership patterns among the research unit supervisors were characterised as laissez-faire, participatory, and directive In general, research teams with participatory leaders had significantly more positive attitudes towards their supervisor, were more highly motivated and had a greater sense of progress Baumgartels (1956) findings suggest that leadership styles are associated with a research teams motivation and their sense of progress towards scientific goals An obvious weakness of this study is its failure to show any direct relationship between the leadership styles of research supervisors and objective productivity measures of the research unit However the implied relationship between

motivation and performance is supported by more recent research on the affects of leadership on unit performance (Bland & Ruffin, 1992, Chawla & Singh, 1998, Hurley, 1997)

A more recent attempt to study the motivational profile of scientists in research and development organisations was conducted by Kamalanabhan, Uma and Vasanthi (1999) Using the concept of Maslow's hierarchy of needs, the study attempted to determine whether scientists are motivated by higher or lower order needs The results suggest that while scientists have a high drive for self-actualisation, this drive is neutralised by barriers to the fulfilment of lower order needs The potential for scientific achievement is reduced if the scientists are overly concerned with meeting basic needs rather than focusing their energies on satisfying higher order needs

These findings have potentially interesting implications for the research organisation If the structure and policies of the organisation do not satisfy the basic needs of the scientists' employed there, then the scientist's behaviours will be directed towards such need satisfaction Consequently such a situation diverts energies away from the achievement of higher order needs (and grand scientific goals) and towards lower order needs (and mundane and routine organisational behaviour) Though this offers an interesting perspective on the motivation of scientists, the use of Maslows needs' hierarchy in this study is a cause for some concern As we will see in the next section, which reviews traditional motivational theories, Maslow's theory has enjoyed much popularity in general terms, but it is believed to be theoretically unsound, and of little practical use

While conducting a large-scale study on scientists in organisations, Pelz and Andrews (1976), examined the level of dedication of scientists to their work A set of five items was included in their battery of questionnaires that were used to measure dedication to work These items asked scientists to indicate the degree to which they felt involved and identified with their work An analysis of results found that the dedication items showed significant positive relationships to both ratings of performance and actual scientific outputs, for scientists of differing types and different laboratories Certainly the strength of the relationships was poor (r = 0 2 to 0 3) but they were found to be consistent and positive Despite the relative statistical weakness of the results these findings highlight the possible significance of motivation and dedication to the performance of scientists

Later work carried out by Unesco (1979) again tried to examine the relationship between the strength of motivation of a scientist and his/her performance This research examined the relationship between strength of motivation and performance at the level of the research unit, rather than the individual It was found that there was generally a positive relationship between strength of motivation within the research unit and various measures of performance Although the relationship was positive it was also weak (a highest correlation of r= 0 3 with most between 0 1 and 0 2) These results support the earlier work of Pelz and Andrews (1976) but again offer little insight into the nature of the relationship between a scientist's motivation and their performance

The possible reasons for such weak relationships are many It may be that motivation and performance are only tenuously related, though intuitive examination and

continuing work on motivation and performance would suggest otherwise (Amabile, 1994, Hurley, 1997) A more likely explanation is the fact that the measurement instruments used in both the Prelz and Andrews (1976) and Unesco (1979) studies attempted to measure the strength of motivation with only a few simple statements related to the concept It is also the case that no direct efforts were made to control for other individual or environmental characteristics that have been shown to be related to scientific performance Certainly the work environment may have a significant part to play in our understanding of the relationship between motivation and performance

Unesco (1979) found that there was typically twice as much variation between research units as there was within research units on the *strength of motivation index* This greater similarity within research units may be attributable to common environmental or organisational conditions, which in turn relate to common motivational influences within certain research units

As we can see, despite the assertions of researchers such as Amabile (1994) and Hurley (1997) that motivation is an important factor in understanding scientific performance, little is known about its exact role in scientific effectiveness To better understand this area much more work needs to be done To aid our understanding of the influence of motivation on scientific research performance several aspects of work motivation must be examined Firstly a motivational profile of scientists is required The benefit of such a profile is its ability to inform us of the specific motivational characteristics of scientists In addition to this a detailed examination of the organisational characteristics that influence and affect the motivation of scientists is required This information would facilitate our understanding of how the research

environment might hinder or promote scientific effectiveness through the process of influencing scientist's motivations Finally an examination of the degree of congruence between the motivational profile of the scientist, and the organisational environment is required This would help to determine the degree to which the similarities and differences between scientists and organisations, influences scientific performance

In order to examine such relationships, a review of current motivational theories is required, to determine their suitability to the current study The next section reviews the traditional theories of work motivation and examines their suitability for use in the current study

4.3 A review of motivational theories

This section reviews motivational theories under two major headings, need-based perspectives, and process based perspectives These categories are generally viewed as the main directions in which motivational research has been conducted in the previous sixty years The need-based perspective includes the motivational theories of researchers such as Maslow (1943), Alderfer (1969, 1972), Herzberg (1968) and McClelland (1961) While the motivational theories classified under the process-based perspective include those developed by Adams (1963), Vroom (1964), Porter and Lawler (1968), Hackman and Oldham (1976), and Locke (1968)

4 3 1 Needs-based perspectives of motivation

The Need theories of motivation represent the starting point for contemporary research in the area of work motivation Need theories operate from the basic premise that human behaviour is directed by deficiencies in one or more human needs The best known of the need theories is Maslow's (1943) Hierarchy of Needs Maslow's Hierarchy of needs is based on the belief that human beings have innate desires to better themselves and their position The stages of his hierarchy range from basic physiological needs to the ultimate need for self-actualisation

While originally Maslow's theory was meant as a general theory of human motivation and personality development it was readily applied to the organisational setting

Maslow's Hierarchy of Needs		Organisational Examples
* Self-Actualisation	=	Challenging and fulfilling job
* Esteem Needs	=	Recognition, awards, promotion
* Need to Belong	=	Co-worker relationships, personal relationships
* Security Needs	=	Job security, fair work practices, pension plan
* Physiological Needs	=	Wages, adequate working environment

Figure 4 1 Maslow's Hierarchy of Needs

As suggested by Maslow's theory if we wish to motivate employees in the workplace then we must put in place the structures and procedures that allow them to ascend the hierarchy and continue towards self-actualisation While the Hierarchy of Needs has received some popularity and may seem to be intuitively quite sound it does suffer from several weaknesses For instance Maslow postulated that people would only try to satisfy higher needs if lower ones have been satisfied However this does not explain individuals who engage in hunger strikes or purposefully engage in dangerous activities Additionally, Maslow's theory has proved difficult to test empirically and has been subject to various interpretations Reviews of the theory have found little support for it and question its validity (Wahba & Bridwell, 1972) Conflicting arguments are common in Maslow's writings mainly due to his attempts to modify his theory to deal with individual variation His descriptions and criteria for self-actualisation are also very varied As a result of this, what was intended as a scientific approach to human personality development and motivation has become more of a popular philosophy

The next motivational theory examined is Alderfer's (1969) ERG Theory This is also a needs theory, but differs from Maslow's in some respects ERG stands for Existence, Relatedness and Growth Alderfer's existence needs roughly correspond to Maslow's physiological and security needs His relatedness needs are similar to Maslow's belonging and esteem needs and finally Alderfer's growth needs are comparable to Maslow's need for self-esteem and self-actualisation Despite these similarities there are several important differences between the work of Maslow and Alderfer

Alderfer's theory allows for the motivational influence of more than one need at a time He suggests, for example, that a person may be motivated by relatedness and growth needs simultaneously In addition to this multi-motivational concept Alderfer's theory also allows for human frustration and regression For example if an individual meets their relatedness needs and progresses to growth needs, but is frustrated or incapable of meeting their growth needs, then they may revert to relatedness needs as their primary motivator Like Maslow, Alderfer's ERG theory has not faired well in comprehensive tests The content of the need categories lacks precision, and measurement of the importance and satisfaction of needs is difficult Research support for the existence of the three categories is also mixed, with some research offering only weak support for the relatedness category in particular (Wanous & Zwany, 1977) In addition the classification of general needs does not aid managers and professionals in their understanding of what specific work characteristics are related to specific needs

Herzberg's two-factor theory is similar to the need theories of Maslow and Alderfer in that it looks at the needs of individuals and how they effect a person's motivation and job satisfaction Maslow and Alderfer look at human motivation as a continuum of needs from basic (physiological, existence) to advanced (self-actualisation, growth) However Herzberg (1968) suggests that the factors involved in producing job satisfaction and motivation are separate and distinct from those factors that lead to dissatisfaction Thus the opposite of satisfaction is not dissatisfaction but rather "no satisfaction" Similarly the opposite of dissatisfaction is "no dissatisfaction" Therefore Herzberg's theory does not represent motivational factors as a single

continuum but rather as a function of two separate unipolar factors of satisfaction and dissatisfaction

Herzberg's theory is based on the published research contained in his book The Motivation to Work (Herzberg, Mauser, & Synderman, 1959) In this theory, also known as the Motivation-Hygiene Theory, he identifies two sets of needs, motivational needs and hygiene needs, which as we have mentioned are related to two separate continua of satisfaction and dissatisfaction Herzberg's unipolar motivational factors include achievement, work itself, responsibility, and advancement While the presence of these factors may lead to job satisfaction their absence does not cause dissatisfaction Herzberg's hygiene factors include working conditions, salary, job security, and company policy and administration From his research he concluded that "a 'hygienic' environment prevents discontent with a job, but such an environment cannot lead the individual beyond a minimal adjustment consisting of the absence of dissatisfaction" (Pugh, 1997, p 375)

This theory offers an interesting alternative to the single continua theories of Maslow and Alderfer However the theory has been severely scrutinised and some criticisms have been weighed against it Though follow up studies using the same methodology have found similar results to Herzberg Attempts to verify the theory using alternative methodologies have been unsuccessful (Hinrichs & Mischkind, 1967) This inability to produce similar findings through different methods leads many to question the validity of the theory Also given the rather restricted sample of engineers and accountants used in the initial study, its generalisability is also in question House and Wigdor (1967) draw attention to the influence of individual differences in the two-

factor theory For example they found that a given factor may be a cause of job satisfaction for one person but dissatisfaction for another They conclude that the two-factor theory is an over-simplification of the sources of satisfaction and dissatisfaction Further criticism comes from a cross-cultural examination of the Herzbergs theory, with some evidence suggesting that the dual-factors may vary across cultures (Adler, 2001)

The final need based theory to be examined is that of McClelland (1961) McClelland put forward another needs theory, which differed from Alderfer and Maslow in one important respect While other needs theorists tried to identify a general set of needs that are common to all McClelland (1961) suggested that needs are learned, and are then arranged in a hierarchy of potential for influencing behaviour Consequently individual needs vary from person to person and the needs hierarchy for each person may not be the same As people grow they experience different events, which they learn to associate with positive or negative feelings For example in an achievement situation an individual may have experienced feelings of pleasure As a result that individual will make a large effort to meet a challenge if they feel that achievement striving might be called for McClelland's achievement motivation theory plays an important role in our understanding of entrepreneurs as it helps to explain the desire to achieve by individual effort and to take personal responsibility and credit for the outcomes

Apart from the achievement motivation needs McClelland (1961, 1962, 1976) also discusses power needs and affiliation needs He suggests that within large organisations it is the power needs that drive high-level managers The power need m

conjunction with the affiliation need prevents a person from becoming totally autocratic and self-aggrandising However if affiliation needs are too strong then they will undermine managerial performance (McClelland & Burnham, 1976) McClelland uses the Thematic Apperception Test to measure the achievement, power and affiliation needs of individuals In the test, subjects tell stories in relation to pictures selected to determine the particular motive being studied While the test generally produces agreement among observers in analyses of the same story, it produced less agreement in analyses of stories produced at different times by the same participant This would suggest that motivational dispositions are not constant and an individual's primary motivator may fluctuate or vary across time Despite the weaknesses of the measurement instrument the theory itself has a lot to offer to our understanding of work motivation

As we have seen, the needs based perspectives offer an insight into the interpersonal sources of motivation of individuals There are many conceptual similarities among the need-based theories and they have had some success in describing the factors that motivate human behaviour Despite this success they all suffer from the same weakness, in that they tell us little about the actual process of motivation The next section examines research attempts to overcome this weakness by reviewing the process-based perspectives of human motivation

4 3 2 Process based perspectives of motivation

Process theories of motivation attempt to identify the relationships between the dynamic variables that comprise motivation, and by doing so they further contribute

to our understanding of the complex nature of work motivation The first theory to be examined under this heading is Equity Theory

The Equity Theory of motivation was put forward by Adams (1963), and is derived from the theories of social comparison processes Social comparison processes are concerned with how we perceive ourselves and our situation in relation to others in our social environment In simple terms Equity Theory proposes that if we perceive ourselves as being treated fairly in relation to others then we experience equity However if we perceive ourselves as being treated unfairly in relation to others then we experience inequity and its resulting consequences Equity is determined by comparing the ratio of the individuals' inputs and outcomes with the ratio of inputs and outcomes of others If the individuals ratio of inputs and outcomes is not the same as the 'others' ratio of inputs and outcomes then there is inequity

The theory suggests that if people perceive equity, they have no motivation to change However if they perceive inequity then they can be motivated to behave in several different ways From an organisational perspective an individual may change their inputs by putting more or less effort into their work They may try to change their outcomes by trying to get a pay rise or improving their work terms and conditions The individual may re-examine their situation and change their perceptions of their own inputs and outcomes They may re-examine their situation and change their perceptions of 'others' inputs and outcomes They may change the 'other' they are comparing themselves with, or finally they may simply remove themselves from the situation

The equity theory has had some success in its application, though mainly in one direction That is, it can predict behaviour when people perceive themselves as being undervalued in the workplace, but generally it does not hold when people perceive themselves as being overvalued in the workplace (Cosier & Dalton, 1983) Another weakness of the theory is that most supportive research is laboratory based, which results in the questionable generalisability of the theory Its application and validity in the real world is not yet verified Research also suggests that sensitivity to equity or inequity may vary among individuals, adding weight to the importance of considering individual difference when looking at motivation at work (Huseman, Hatfield, & Miles, 1987)

The organisational application of another motivational theory known as the Expectancy Theory was put forward by Vroom (1964) The basic reasoning behind the expectancy theory is that motivation depends on how much we want something and how likely we are to get it The theory can be broken into several stages, which are, effort, performance, and outcomes The two key concepts surrounding these stages are the 'effort-performance expectancy' and the 'performance-outcome expectancy' Effort-performance expectancy is related to our belief in the likelihood that a given effort will result in a level of performance Similarly the performance-outcome expectancy is related to our belief in the likelihood that our performance will lead to a given set of outcomes Therefore an individual will be motivated if they believe that their effort will lead to a sufficient performance that will result in the desired outcomes Consequently if an outcome is undesirable or a performance is

unattainable then the individual will exert no effort because they will not be motivated

Porter and Lawler (1968) conducted an extension and modification of Vroom's original theory Though traditionally researchers had viewed satisfaction as an influencing factor on performance, Porter and Lawler argued that if conditions were right then performance may lead to satisfaction This led to the proposition that the performance outcome of Vroom's (1964) model resulted in two kinds of rewards, Intrinsic and Extrinsic The attainment of these rewards then influenced the individual's level of satisfaction Consequently, in future situations the level of satisfaction attained would influence the value that the individual attached to future rewards, which in turn influenced the strength of their motivation and performance in a cyclical process

The expectancy theory offers a logical framework from which to view human motivation and it does contribute to our understanding of behaviour in organisations (Fox, Scott, & Donohue, 1993) However its complexity has been hard to verify and the scientific formulation of some of the concepts has proven difficult Instruments developed for measuring many of the variables in the model have also lacked validity (Pinder, 1984) These problems have stifled the development of expectancy theory and limited its acceptance as a practical and useful theory of motivation

A further approach to the understanding of work motivation comes from the Job Characteristic Theory of Hackman and Oldham (1976, 1980) Hackman and Oldham (1980) developed a framework of job characterisation to predict job performance

under varying circumstances, and therefore be able to identify job characteristics that may be altered to increase satisfaction ratings Hackman and Oldham also take account of individual moderators such as a person's knowledge and skill, the strength of the individual's growth need and the level of the individual's job satisfaction These factors interact with job characteristics and critical psychological states to produce outcomes This is illustrated in figure 4 1

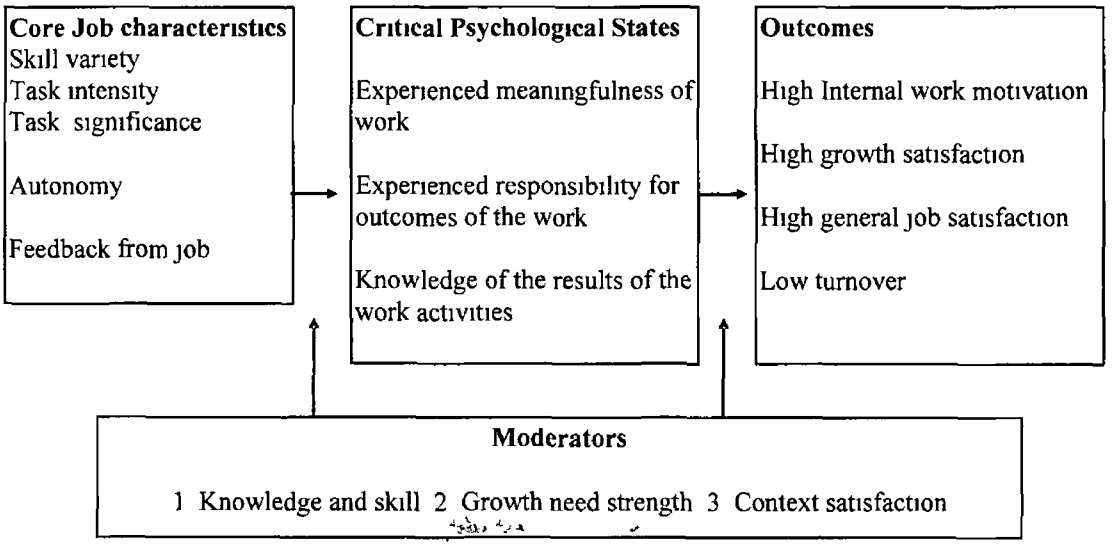


Figure 4 1 Illustration of Job Characteristic framework (Hackman & Oldham, 1980)

The job characteristic theory has been found to be accurate in describing how core job characteristics generally operate (Roberts & Glick, 1981) Research also indicates that the growth-need moderator does act as the theory suggests Individuals with strong growth needs are more likely to benefit from job enrichment Despite these positive findings the theories of job enrichment and job characteristics have fallen short of there hoped for potential Performance has seldom been found to correlate with job characteristics (Griffin, Welsh, & Moorhead, 1981) The validity and reliability of some of the instruments used to measure some of the concepts contained within the theory have also been questioned (Cordery & Sevastos, 1993) Again we see the

difficulty in transferring a theoretical framework into a practical and usable motivational model

A further theory related to work motivation, is that of Locke (1968) Locke's theory of goal setting is based on the proposition that individuals who are assigned difficult and specific goals outperform those who are given vague, non-specific assignments Locke, Shaw, Saari, and Latham (1981) proposed that the setting of goals influenced an individuals behaviour in four key ways (1) directing attention, (2) mobilising effort, (3) encouraging task persistence, and (4) facilitating strategy development Two attributes of the goal itself were also found to be important, the intensity of the goals and the content of the goal The intensity of the goal refers to the individual's perceived importance of the goal and commitment to the goal The goal content refers to the features of the goals such as its difficulty, and complexity

While goal theory has had success in certain work domains, it is not always appropriate In increasingly dynamic and changing work environments, the ability to set specific and unchanging goals can be limited Additionally for very complex tasks and problems with unknown solutions (such as complex scientific problems), the concept of structured goal setting is inappropriate Consequently the usefulness of the goal setting theory to the understanding of the motivation of scientists is limited

4 4 Summary of classical motivational theories

As we can see from this review no one theory of motivation stands aloft as a truly accurate and reliable model of the way in which motivation influences workplace

behaviour Each theory suffers from conceptual or practical weakness that makes them inappropriate for use in the current study What is required at this stage is an integrated model of motivation with a strong theoretical basis and a basic propositional framework that allows for flexibility in its approach to individual differences and organisational characteristics Such a model is presented below

4 5 An integrated approach to motivational research

To date reviews of research in the area of work motivation have been inconclusive in their attempts to identify a single reliable theory of motivation, or unifying the many conceptual theories that exist As is evident from the previous section the various motivational theories in existence have had only limited success in describing, explaining and predicting human behaviour in the work place Additionally, this success is generally limited to specialised circumstance and conditions (Kanfer, 1992) Barbuto and Scholl (1998) highlight the long and exhaustive arguments over the merits and weaknesses of many motivational perspectives including psychosocial (Jung, 1971), expectancy (Lewin, 1938, Vroom, 1964), need-based (Maslow, 1954, McClelland, 1961), value-based (Etzioni, 1961), self-concept-based (Gecas, 1982, Sullivan, 1989), goal setting (Locke & Lantham, 1984), intrinsic (Deci, 1975), and developmental (Kegan, 1982, Piaget, 1972) Given the continuing disagreement over the strengths and weaknesses of various theories, what is required is an attempt at integration of some of the major concepts contained within these theories

Recent attempts have been made to overcome the theoretical complexities and practical difficulties of the many motivational theories in existence Leonard,

Beauvais, and Scholl (1999) propose an integrated model of motivation, following an extensive review and analysis of the relevant literature Their research is based on the growing realisation that the existing traditional models of motivation fail in their attempts to explain and predict the diversity of human behaviour Leonard et al (1999) attempt to overcome current weaknesses in motivational theory by presenting a meta-theory of work motivation In doing so they identify five key motivational sources, the importance of which is mediated by several theoretical propositions

The five sources of motivation include (1) intrinsic process motivation, (2) instrumental motivation, (3) external self-concept motivation, (4) internal self-concept motivation and (5) goal internalization motivation

Intrinsic process motivation describes a person's motivation to perform certain kinds of work or engage in certain kinds of behaviour for the sheer fun of it The work itself serves as the primary incentive to perform because the individual enjoys what they are doing

Instrumental motivation describes an individual's motivation to perform a task or engage in behaviours because they perceive their efforts will result in a tangible outcome This outcome may be pay, promotion, or some other tangible reward

External self-concept motivation describes an individual's motivation to engage in certain behaviours, for the approval of others The self-concept is inferred from the role expectations of reference groups, with the individual seeking affirmation of competencies and traits from others

Internal self-concept based motivation describes an individuals motivation to perform in order to reinforce their internal standards of traits, competencies and values This concept of the ideal self serves to motivate the individual to perform in ways that reinforces this concept

Finally goal internalization motivation describes an individual's motive to perform because the content of the behaviour is congruent with their personal value system In such instances individuals may believe in a cause and consequently work towards a collective goal

The propositions for the Meta theory of work motivation as outlined by Leonard et al (1999) are as follows

P1 There are five basic source of motivation (listed above)

P2 Individuals can be characterised by motivational profiles, which reflect the relative strength of each of the five sources

P3 For every individual there is a dominant source of motivation that acts as a focus by which they make decisions and channel behaviour

P4 When two or more sources of motivation within an individual conflict the dominant one will prevail

P5 Individuals have different motivational source profiles in different situations or with regard to different identities

P6 When faced with alternative tasks, individuals dominated by intrinsic process motivation will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable

P7 When faced with alternative tasks, individuals dominated by instrumental motivation will engage in the task that provides the greatest potential for extrinsic rewards, and the behaviour will be sustained as long as the likelihood of attaining those rewards remains

P8 When faced with alternative tasks, individuals dominated by external self-concept based motivation will engage in tasks that provide them with affirmative social feedback relative to others, concerning their traits, competencies, and values in their important identities Behaviour will be sustained as long as relative, positive social feedback is forthcoming

P9 When faced with alternative tasks, individuals dominated by internal self concept based motivation will engage in tasks that provide them with affirmative task feedback about their traits, competencies and values in their important identities Behaviour will be sustained as long as positive task feedback is forthcoming

P10 When faced with alternative tasks, individuals dominated by goal-internalization motivation will choose to engage in tasks that have the greatest potential of achieving

the groups or organisations goals Behaviour will be sustained as long as progress towards those goals continues

While the integrated model of source motivation, does not conform to any one motivational theory, it is not atheoretical Its purpose is the integrative understanding of a number of motivational theories, and by moving away from the specifics of a particular theory, the model allows for a better practical understanding of the concept of motivation as a multi-dimensional and complex phenomenon In particular the model is useful for investigating the work setting, as it allows for the recogmtion of multiple motivational sources for influencing behaviour Additionally it recognises personal differences in the degree to which various motivational sources are of importance to different individuals, and the complex way in which the work environment may influence the motivational sources of the individual The ten propositions of the theory also present a strong theoretical framework from which to view and apply the theory

The greatest asset of the meta-theory of motivational sources is its new and integrative approach to the area of work motivation Unfortunately this is also its greatest weakness Due to the relative novelty of the theory it has not been fully tested and verified However initial research has been favourable Barbuto and Scholl (1998) developed an instrument to measure the five motivational sources described in the motivational source theory The Motivational Source Inventory developed by Barbuto and Scholl (1998) provides a useful measurement of the five motivational sources identified by Leonard et al (1999) The inventory is comprised of five subscales each containing six items relating to each of the five motivational sources The goodness of

fit for the five subscales is reported at 92, while the alpha coefficients of the scales range from an acceptable 83 to 92 These results show support for the five motivational concepts, as distinct factors that can be operationalised and measured

There are many benefits to using the Leonard et al (1999) motivation source theory The theory has been developed from a sound theoretical base, following the analysis of traditional motivational theories Due to the integrated nature of the theory it allows for researchers to examine a wider set of motivational sources The motivational sources in question are also well defined and structured It enables the profiling of motivational sources for a given sample and the key propositions of the theory allow for a flexible approach to the study of individual differences Importantly, while motivational source theory can be used to profile individuals, it can also be used to profile the degree to which an organisation provides for or facilitates the motivational sources of its employees In this way it allows the researcher the opportunity to examine the congruence between the individual's motivational sources and the organisations motivational provisions And it is in this regard that it will be employed in the current study

In the current study the motivational source model will be used to firstly profile the motivational sources of the sample of research scientists, in an attempt to better understand the factors that motivate the scientist in their work Secondly it will be used to profile the motivational provisions of the work environment, so as to shed light on the environmental factors that influence the motivation of scientists Finally it will be used to examine the relationship between both individual sources of

motivation and organisational provisions of motivation, and how the interaction of these two concepts relate to an outcome measure of scientific performance

CHAPTER FIVE

A FRAMEWORK FOR THE STUDY OF THE RELATIONSHIPS BETWEEN SCIENTISTS MOTIVATION, THE ORGANISATION IN WHICH THEY WORK, AND RESEARCH PRODUCTIVITY

5 1 Introduction

Throughout the previous chapters research related to the current study has been reviewed Literature relevant to the organisational characteristics related to scientific effectiveness has been presented as well as existing models relating to scientific performance In addition, a review of motivational theory and literature relevant to the study of motivation within the research organisation has been presented While the previous chapters have been predominantly descriptive in nature, the current chapter presents a more theoretical approach through the development of a testable model of research effectiveness

5 2 Developing a model from previous research

As is evident from the research summarised in the previous chapters, the 'picture' of our understanding of the research environment and its relation to scientific performance is an incomplete one Various models have been put forward in an attempt to explain research performance, each with its own strengths and weaknesses The current study seeks to advance our understanding of scientific effectiveness by incorporating many of the strengths of previous research through the development of

a testable framework of scientific effectiveness This framework incorporates three key propositions from research reviewed in the previous chapters

Proposition 1 There are a number of identifiable and measurable organisational characteristics that influence the effectiveness of scientific research (As proposed by Thamhain and Wilemon (1987), Unesco (1979) and Hurley (1997))

Proposition 2 The optimal interaction between organisational and individual characteristics increases the likelihood of effective scientific outcomes (As proposed by Hurley (1997))

Proposition 3 Motivation is an important concept in our understanding of scientific effectiveness (As proposed by Baumgartel (1956), and Amabile (1988))

By bringing these propositions together it is possible to develop a testable model of research effectiveness that will aid our understanding of the complex interactions that occur between the individual scientist and the research organisation, and how these interactions relate to scientific effectiveness

5.3 The characteristics of the research organisation that influence scientific effectiveness

As evident from the literature presented in chapter three, studies relating to the organisational environment of scientific effectiveness have been inadequate in explaining the relationship between the organisational environment and research

performance Though some positive steps have been taken in the recognition of the importance of the environment to scientific effectiveness (Amabile, 1988, Hurley, 1997, Thamhain & Wilemon, 1987, Unesco, 1979) Additionally several researchers have identified specific characteristics of the research environment that have been found to be related to scientific effectiveness (Argyris, 1968, Baumgartel, 1956, Bland & Ruffin, 1992, Chawla & Singh, 1998, Mouly & Sankaran, 1998)

However, while identifying the existence of a relationship, these researchers have stopped short of explaining how these factors influence the effectiveness of scientists The following framework aims to overcome this weakness by explaining how the organisational environment interacts with the individual scientist to affect scientific performance This is done by presenting a hypothetical model of the interaction between the motivational sources of the scientist and the environmental characteristics of the research organisation

It is beyond the scope of this study to incorporate every organisational characteristic that has been shown to be related to scientific effectiveness Therefore only a limited number of the characteristics can be included in the hypothetical model developed for the current study The difficulty at this stage is deciding which characteristics are of critical importance

As described previously in chapter three, Baumgartel's (1956) research on the attitudes and motivations of scientists identifies several leadership characteristics that are related to scientists job satisfaction and their motivation to engage in research Argyris (1968) identifies nine basic variables that influence the effectiveness of the

research organisation These include organisational structure, technology, administrative controls, human controls, leadership styles, interpersonal relations and communication, group effectiveness, intergroup relations, and norms of the living system Bland and Ruffin (1992) identify twelve characteristics found in productive research environments These include the existence of clear goals that serve a co-ordinating function, a research emphasis, a distinctive organisational culture, a positive group climate, assertive participative governance, a decentralised organisational structure, the size age and diversity of the group, the reward structure of the organisation, frequent and open communication, a well developed recruitment and selection process, adequate resources, and finally effective leadership

Factors identified by Hurley (1997) include many of those identified by Bland and Ruffin (1992) with the addition of others such as team autonomy, group morale, group membership, and supervision of the research team Utilising an ethnographic approach, Mouly and Sankaran (1998) identified several factors which characterise the dysfunctional research environment Factors such as excessive bureaucracy, lenient selection and recruitment, lack of team identity, lack of autonomy, poor interpersonal relations, and authoritarian and apathetic supervision Utilising a data set from a further round of the Unesco (1979) study Chawla and Singh (1998) identified several organisational characteristics related to research productivity These organisational characteristics were chosen for their ability to describe the effectiveness of research organisations in terms of management practices and resources, and were used to identify five distinct types of research organisations with varying levels of effectiveness The characteristics themselves are leadership, work environment, policies, planning, communication, and resources

Table 5 1 Summary of organisational characteristics believed to influence scientific effectiveness

ARGYRIS (1968)	BAUMGARTEL (1956)	GLUECK & THORP (1971)	THAMHAIN & WILEMON (1987)	BLAND & RUFFIN (1992)	HURLEY (1997)	MOULY & SANKARAN (1998)	CHAWLA & SINGH (1998)
Organisational structure	Leadership	preparation and planning	Leadership	Clear goals	Good selection processes	Lenience in recruitment processes professional mediocrity	Leadership
Technology	Freedom in decision making	organisation/ coordination	Job content	Research emphasis	High morale	Poor self image	Work environment
Administrative controls		control/ conflict	Personal goals	Distinctive organisational culture	Positive group member-ship and supervision	Lack of team identity and role clarity	Policies
Human controls		organisation climate	Work environment	Adequate recruitment and selection process	Autonomy of work teams	Lack of institutional autonomy in project selection	Communica tion
Leadership styles		evaluation		Assertive participative governance	Supportive organisa tional culture	Excessive bureaucracy apathetic attitudes	Resources
Interpersonal relations and communication				Decentralised organisational structure	Effective communica -tion	Strained interpersonal relationships	Planning
Group effectiveness				Size age and diversity of the group	Effective leadership styles	Apathetic supervision authoritarian-ism within the institutes hierarchy	
Inter group relations				Appropriate reward structure			
Norms of the living system				Frequent and open communica tion			
				Positive group climate			
				Adequate resources			
				Effective leadership			

The summary of organisational characteristics presented in table 5 1 highlights the need for any model of the organisation and scientific effectiveness to encompass as many of these concepts as possible It also highlights the degree of conceptual similarity among many of the factors identified across the various studies summarised here, and poses questions as to how to empirically measure the concepts presented in table 5 1

Several possibilities presented themselves with regard to the identification of appropriate instruments to measure the organisational characteristics identified in table 5 1 The first and most obvious approach was to incorporate the wide range of instruments employed in existing research on the topic of scientific effectiveness into a suite of instruments to be used in the current study Following a detailed review of the literature it was decided not to take this approach The logic and rational for this decision is presented in the following section

The research studies summarised in table 5 1 take a variety of methodological approaches, which limits the likelihood of being able to adequately integrate the variety of measurement approaches for use in the current study For example Argyris (1968) employed a primarily reflective theoretical approach to the investigation of factors that influence the effectiveness of research organisations This approach was supplemented by a qualitative investigative approach, whereby he analysed 250 taped interviews with supervisors in research organisations Consequently no actual quantitative measures, which could be incorporated into the current study, were used to collect and provide empirical evidence in support Argyris (1968) work

Mouly and Sankaran's (1998) work was also of a qualitative nature Essentially this study was an ethnographic examination of a research and development organisation in Indian, with the results presented by Mouly and Sankaran being derived from the ethnographic analysis Consequently, as no quantitative measurement instruments were used in this study it offered little insight into the quantitative measurement of the factors identified in the study

While Hurley (1997) took a more structured approach to the collection of data used in the development of his theory of organisation and scientific discovery, the methodology employed was still essentially qualitative Hurley conducted several structured interviews and also collected some questionnaire data However the questionnaires used were essentially descriptive in nature and only collected information on the issues of chance, freedom, and selection practises In addition no statistical reliabilities are reported for the items of the questionnaires nor were any investigations into the validity of the instruments carried out This lack of reliability and validity led to their exclusion for consideration for use m the current study

Similarly Thamhain and Wilemon's (1987) work provided little aid in the identification of quantitative measurement instruments that could be suitable for use in the current study In the case of Thamhain and Wilemon, the majority of evidence used in the development of their systems model of research performance was based on data collected from unstructured interviews This information was augmented by data collected using some short questionnaires However where questionnaires were used they were linked to specific organisational theories such as French and Raven's (1959) typology of power In addition to this, many of the concepts measured in the questionnaires employed by Thamhain and Wilemon used only one or two questionnaire items to measure a concept of the organisational environment This raises serious doubts over the validity and reliability of these instruments and consequently precludes their use in the current study

Glueck and Thorp's (1971) annotated bibliography of research on the management of science provides a very useful summary of historical examinations of the organisation

of science Once again there was a lack of reference to usable measures that could be incorporated into the current study, and were reference was made to quantitative instruments, such references were linked to specific organisational theories of the time A decision was made to seek more contemporary measures of the organisational environment as the relative age of the work, and the consequent relative ages of the research referred to in this annotated bibliography limited its usefulness in relation to instrument identification

In the case of Bland and Ruffin (1992), the organisational factors presented in their work were identified following a review of literature on the organisation and scientific effectiveness The nature of the literature, much of it theoretical or qualitative in nature, precluded the use of meta-analytic procedures, leading to what is described as an intellectual synthesis of findings that offered little aid in identifying quantitative measurement instruments suitable for use in the current study Bland and Ruffin's (1992) research is useful in that it shows how factors with conceptual similarity from a variety of sources can be integrated into meaningful categories

In the case of Baumgartel (1956) the measurement instruments employed were quantitative in nature Leadership characteristics and characteristics relating to freedom in decision making, and involvement in decision making were measured using responses on a Likert type scale to statements conceptually related to those characteristics However, in most cases as few as two statements were used to measure the concepts examined In addition to this the instruments themselves were not presented nor was information relating to the validity or reliability of the instruments presented

Finally Chawla and Singh's (1998) work on the identification of typologies of research institutes offered some potential for instrument identification Their research employed data collected in a more recent round of the Unesco (1979) study into the effectiveness of scientific research Despite persistent attempts to contact the researchers and attain a copy of the instruments used in the collection of their data, no such information was forthcoming However, reference was made to the questionnaire items used in the original Unesco (1979) study, which are available in the appendices of that publication An examination of these instruments suggested that a number of them might be suitable for incorporation into the current study Of particular use were the Unesco (1979) instruments relating to supervision/leadership and participation and planning of research However, the possible use of these instruments still required the identification of additional instruments to cover a wider range of concepts identified in the literature review

The investigation of methods used to identify organisational characteristics of significance to the current study highlights the complexity of approaches and various methodological perspectives that can be taken when examining aspects of the work environment It also highlights a problem that must be addressed in the current study That is the identification of a quantitative measure of organisational characteristics, whose content adequately reflects and measures the variety of concepts contained in table 5 1

As discussed previously the most intuitive and logical approach to the measurement of those organisational characteristics believed to influence the performance of

scientists is to integrate existing measures that have shown relationships between the environment of science and scientific research effectiveness However as evident from the examination of research on the organisation of scientific research, presented in the previous paragraphs, the methodological disparity, and lack of easily identifiable quantitative instruments to operationalise many of the organisational characteristics identified in the literature does not facilitate this approach

An alternative perspective is to view the organisation more holistically, and examine the possibility of applying existing measures of organisational characteristics to the study of the specific organisation of science Such approaches have been taken in the study of organisations, in particular such an approach is evident in the study of the overriding concept of organisational 'culture'

The concept and term organisational culture in academic literature can be traced back to Pettigrew (1979) The concept of culture began as, what has been described as, a management 'fad' but its value was quickly recognised and it has become a primary area of organisational research (Hofstede, Neuijen, Ohayv, & Sanders, 1990) spawning many definitions, interpretations, and measurement instruments Argument still exists over the actual definition and conceptualisation of culture, but several useful definitions have been put forward in the literature Deal and Kennedy (1982), describe culture as 'the way things are done around here' Such a definition includes wide aspects of organisational member behaviour and organisational processes A more specific definition by Schein (1983), refers to the 'pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaptation and internal integration' An alternative definition

provided by Koberg and Chusmir (1987) explains the concept of organisational culture as 'a system of shared values and beliefs that produce norms of behaviour and establish an organisational way of life' Recognition of the variety of, and difference in the definition of organisational culture is important, because subtleties within these definitions drive how various researchers in the area of organisational culture operationalise the concept of culture

Two broad components of organisational culture that exist in the literature, and can be identified in definitions of the concept include the examination of culture as (a) a set of cognitions (i e) values and beliefs, and (b) the outcome of these values and beliefs in the form of observable behavioural components It is the latter aspect and perspective of culture that is of possible interest to the current study The examination of behavioural norms across various dimensions of the organisation relate directly to what can also be viewed as the characteristics of the research organisation Essentially such measures operationalise culture by examining behavioural norms across various dimensions of organisational functioning Such dimensions of organisational functioning can include factors such as leadership, communication, teamwork or other characteristics of the research organisation identified in this literature review

To allow comparison across various research organisations, in the current study, quantitative measurements of dimensions of the organisation are required Several quantitative measurement instruments have been designed to assess aspects of organisational culture across various types of organisations These instruments measure culture through the examination of *a priori* generic characteristics of typical organisations However their usefulness in the current study may be severally limited,

as it is important that the generic characteristics measured in any survey of organisational culture relate closely to those specific characteristics identified as being important in the organisation of scientific research

An examination of measures of organisational culture identified several potentially useful instruments These included the Organizational Culture Profile (O'Reilly, Chatman, & Caldwell, 1991), the Organizational Culture Inventory (Cooke & Lafferty, 1983), the Organizational Culture Survey (Glaser, Zamanou, & Hacker, 1987), the Organizational Culture Assessment Instrument (Cameron & Quinn, 1999), the Comparative Emphasis Scale (Ravlin & Meglino, 1987) Organizational Culture Instrument (van de Post, de Coning, & Smit, 1997), Organizational Norms Opinionnaire (Alexander, 1978), the Organizational Culture Index (Wallach, 1983), the Culture-Gap Survey (Kilman & Saxton, 1983) and Hofstede's dimensions of organisational culture (Hofstede et al, 1990)

The potential usefulness of any of these instruments was bound by the necessity that the factors they measured exhibited strong conceptual relationships with the characteristics of the organisation that are believed to influence scientific effectiveness Preliminary examinations of these instruments found that many did not in fact meet this requirement In some instances the instruments in question focused solely on the value and belief aspects of organisational culture, not attempting to measure the actual behavioural experiences of the organisations members that would relate to specific characteristics of the research organisation This was true for instruments such as the Organizational Culture Profile (O'Reilly et al , 1991), the Organizational Culture Inventory (Cooke & Lafferty, 1983), the Culture-Gap Survey

(Kilman & Saxton, 1983), the Comparative Emphasis Scale (Ravlin & Meglino, 1987) and the six dimensions of organisational culture identified by Hofstede (1990) Other measures such as the Organisational Culture Index (Wallach, 1983) contained too few dimensions to offer useful conceptual explanation of the characteristics of the research organisation identified in the review of literature in the current study

Of the remaining measures that did offer some relationship between the factors they measured and the influencing factors identified in the literature review, one stood out quite clearly, offering conceptual similarity between its concepts and the concepts identified in the literature review, and offering strong evidence of its validity and reliability This instrument was the Organizational Culture Survey (OCS) (Glaser et al , 1987), which measures six factors of organisational culture The six factors contained within the OCS are labeled Teamwork, Morale, Information Flow, Involvement, Supervision, and Meetings An examination of the items that comprise each of the factors also showed that items relate to the direct experience of organisational members in various contexts within the organisation, rather than examining desired or held values and beliefs

Immediate links can be drawn between some of these concepts and the characteristics of the research organisation identified in the literature review For example the characteristic of morale referred to Hurley (1997), or the characteristic of supervision referred to by Mouly and Sankaran (1998) In addition to this a detailed examination of the items that comprise each of the factors of the OCS show that the labeling of some of these factors belie their obvious conceptual relationships to many of the organisational characteristics identified in the literature review The exact nature of

these relationships and the level of synonymy that exists between the factors of the OCS and those characteristics of the research organisation identified in the literature review is further elaborated in chapter six 'The development and selection of measurement instruments for use in the current study '

5 4 Measurement and evaluation of effectiveness in scientific research

In order to examine any organisational variables relating to scientific effectiveness, it is of primary importance to have a valid measure of effectiveness The following section reviews the measures of research effectiveness employed in the studies presented in table 5 1

Argyris' (1968) examination of the effectiveness of research and development organisations presents no objective measure of research effectiveness This work is essentially reflective in nature and applies general principles and theories of organisational functioning within the specific domain of the research organisation The work itself was based on the analysis of taped interviews with 250 supervisors working in research organisations, and it is the analysis of their opinions and experience on the impact of the organisational environment on the effectiveness of their organisation that is presented As such this offers little insight into the measurement of effectiveness in the research organisation

Baumgartel's (1956) work on the relationship between leadership and organisational functioning similarly lacks any objective measure of effectiveness In this instance the primary relationships under examination are those of the link between leadership

styles and the motivation and satisfaction of subordinates, presuming a direct link between motivation and performance As such this study again provides little insight into the possible approaches to the valid and reliable measurement of scientific effectiveness that might be employed in the current study

As mentioned previously, Glueck and thorp (1971) compiled an annotated bibliography of works examining research productivity and the effective management of scientific research No direct measure was described within this work, however several alternative measures are referred to by the many articles and books referred to in this study The majority of these include the use of individual or organisational publications counts and the use of citation counts In addition to these, esteem factors such as science awards are used, as well as more fiscal based evaluations that relate the success of an organisation in attracting research funding as a proxy for its research effectiveness

The systems model developed by Thamhain and Wilemon (1987) followed a similar methodology to the work of Argyris (1968) m that the findings presented in their work are also primarily based on the evaluation and analysis of content from a large number of unstructured interviews with individuals engaged in the scientific endeavour Again we see no readily identifiable measure of scientific effectiveness used in this study Rather their model is developed from the analysis of the individual experience of the participants and their perception of factors that influence their performance and the performance of those around them While this is a valid methodological approach, at the stage of theory development, it provides little

assistance in the identification of a suitable measure of effectiveness for use in the current study

Bland and Ruffin's (1992) review of characteristics of the productive research environment summarises a large number of studies on the influence of the work environment on research productivity This review reflects the variety of approaches that have been taken in the literature to the measurement of scientific effectiveness The most common outcome or performance measures identified by Bland and Ruffin (1992) were the examination of vitas, publication counts of books and articles, peer esteem measures such as awards, the sizes of grants awarded to individuals and organisations, the identification of physical prototypes, patents and blueprints, reputation of the research group, and the application of research results Subjective measures of performance garnered from interviews and questionnaires measuring factors such as morale and satisfaction were also used The most commonly used outcome measures for performance in the literature were the number of articles published and the number of citations that published works received

While Bland and Ruffin's (1992) review does not present a single, readily identifiable measure of research effectiveness for consideration in does highlight the variety of approaches that have been, and can be taken in the evaluation of research productivity and the measurement of scientific effectiveness It also highlights the fact that in most cases some aspect of publication counts and publication quality (i e citation analysis) are viewed as key components in the measurement of research performance

An analysis of Hurley's (1997) work identifies a clear measure of scientific effectiveness In collecting data on the influence of the organisation on scientific discovery Hurley uses the award of the Nobel Prize as a readily identifiable symbol of performance in science This peer esteem measure clearly identifies scientists whose work has been groundbreaking in nature and whose ability as an effective researcher has been recognised by the scientific community While this is a useful criterion for establishing that an individual is an effective scientific researcher, the attainment of a Nobel Prize in a science field is not an overly useful measure of effectiveness at the level of the organisation, and this is reflected in Hurley's (1997) work Essentially the Nobel Prize was used by Hurley to aid in the selection of a number of effective scientists to participate in the data collection phase of his study, it was not used as an outcome measure of research performance, at the organisational level The nature of this measure of research effectiveness is useful however as it identifies the possible appropriateness of peer esteem factors, such as awards, as measures of effectiveness Such factors could be widened to include other international or national science awards such as the US Academy of Science awards

In the case of Mouly and Sankaran's (1998) study a similar approach was taken to Hurley (1997) in that the use of information on scientific effectiveness was used to select research participants rather than as an objective outcome measure of scientific effectiveness In this case Mouly and Sankaran highlight the fact that the participants in their study (a research group known as *Alpha*) were selected for ethnographic study due their readily identifiable status as a dysfunctional research group That is they were known to be ineffective prior to the study This evaluation of 'ineffectiveness' was based on information relating to the poor performance of the group such as not

completing projects on time and running over budget This group essentially offer a polar opposite to Hurley' s Nobel Prize winners on the continua of scientific effectiveness While Mouly and Sankaran's study offers a very useful insight into the organisational environment of the dysfunctional research group its usefulness in informing us as to the appropriate measurement of scientific effectiveness is limited to the identification of such factors as project completion on time and within budget Such factors are certainly useful measures of effectiveness but only account for a very narrow aspect of the potential ways in which scientific effectiveness could be measured

Chawla and Singh's (1998) work offers the most useful insight into the measurement of scientific effectiveness in relation to the current study As mentioned previously Chawla and Singh's research was conducted on a later round of the Unesco (1979) study, which employed a very detailed and wide ranging measure of scientific effectiveness

Originally 56 qualitative and quantitative measures were developed for the Unesco (1979) study, but following further analysis these were reduced to 10 basic performance measures Of these 10 measures, three of them were concerned with measuring the research unit's quantitative output, while the remaining seven measured various qualitative aspects of performance

The quantitative measures were broken down as follows

1 Published written outputs represented by

number of books published in the country (4)

number of articles published abroad (3)

number of articles published within the country (2)

number of published reviews and bibliographies (1)

2 Patents and prototypes represented by

number of patents abroad (4)

number of patents within the country (3)

number of prototype devices, instruments, etc (2)

number of experimental materials (1)

3 Reports and algorithms represented by

number of internal reports on original R&D work (2 5)

number of algorithms (2 5)

number of routine reports (1)

By combining a research units three year production of the products listed above, three composite output measures were constructed Given that each of the items listed in the three measures above are not of equal value, a weighting system was applied A group of investigators conducting the Unesco study acted as judges and allocated a predetermined number of points to each item These results were averaged and the items ranked in the order in which they appear above (the number beside each item represents the weighting which that item received)

The next phase of measurement construction was the development of qualitative measures of performance The composition of these qualitative measures of research productivity included

1 General contribution of the unit

general contribution to science and technology

2 Recognition accorded to the unit

international reputation of the unit

demand for the units publications

3 Social effectiveness of the unit

social value of the units work

usefulness of the units work

4 Training effectiveness of the unit

training effectiveness

5 Administrative effectiveness of the unit

success in meeting schedules

success in staying within budgets

6 R&D effectiveness of the unit

productiveness

innovativeness

R&D effectiveness

7 Applications effectiveness of the unit

applications of research units

use made of development activities

For all of these factors there was at least moderate agreement among the different groups who rated them (i e unit heads, staff scientists, and external evaluators) with regard to the relative performance of the research units Importantly, Unesco (1979) also reports that there was also found to be greater agreement among ratings of the same unit than among ratings of different units The interrelationships among the seven clusters were also found to be reasonably stable across different types of institutions, fields of science and national settings Each of the items that comprised the qualitative effectiveness measures were incorporated into five point Likert scales This effectiveness questionnaire was then administered to unit heads, staff scientists and external evaluators The composite rated effectiveness measures were based on a series of aggregations and transformations The scores of staff scientists from the same unit were averaged to produce a single unit level score for each unit This was also done for the scores of external evaluators

Answers to the individual questionnaire items were combined, again by averaging to produce scores on each of the seven measurements Finally the data were aggregated across the three types of respondents, again by averaging to produce a simple joint rating While it is admitted that the single questionnaire items show some level of imprecision, it is reported in the Unesco study that the internal validities of the composite qualitative measures range from 0 7 to 0 8

This complex measure of research effectiveness offers the strongest, most inclusive and consequently most reliable measure presented in the literature It highlights the complex nature of scientific productivity and the need to incorporate a wide variety of output measures and evaluations into a measure of scientific effectiveness

As we can see from section 5 4 the measurement of scientific effectiveness is not a simple and readily identifiable task It can vary quite significantly in its nature and level of detail from study to study What is clear however is that in order to increase the validity of any measure of effectiveness it is important to incorporate as many of the outcomes of scientific research as possible Such outcomes can include factors ranging from purely quantitative publication counts and citations to more qualitatively subjective evaluations of observers Further attention is given to the topic of the measurement of scientific effectiveness in Chapter six, titled 'The development and selection of measurement instruments for use in the current study'

5 5 The scientist's motivation to perform

As we have seen from chapter three, motivation is a topic of considerable interest when examining organisational behaviour and this is also true in the context of the scientific research organisation One of the primary interests of the current study relates to what drives a scientist to engage in scientific research and persist in their work, despite the high degree of failure that is associated with much scientific investigation Leonard et al (1999) put forward a meta-theory of motivation through which it is possible to examine this Using Leonard et al's (1999) theory it is theoretically possible to identify and 'map' the motivational profile of the scientist Thus enabling us to determine the degree to which scientists are motivated by Intrinsic processes, Instrumental, External Self-concept, Internal Self-concept and Goal Internalization motivation

Establishing the motivational profile of the scientist is a worthwhile pursuit in and of itself However because the current study is concerned with the effectiveness of scientists within the research organisation, it is the goal of the current study to not only identify the motivational profile of research scientists, but also to identify the degree to which the organisation provides for, or facilitates the motivational profile of the scientist

Leonard et al (1999) propose that each individual has a motivational profile This motivational profile is characterised by the degree to which they are motivated by each of the five motivational sources of their theory Leonard et al also suggest that each individual has a dominant motivational source that serves as a primary motivator in determining their behaviour Let us consider for example an individual scientist whose primary motivational source may be the 'intrinsic process' motive identified by Leonard et al Intrinsic process motivation describes a person's motivation to perform certain kinds of work or engage in certain kinds of behaviour for the sheer enjoyment of it Therefore our scientist will engage in scientific research because of the sheer sense of enjoyment of the tasks involved in such research

If the scientist in question is working in an organisation that provides them with a work setting from which they can extract enjoyment from the task they must perform, then we can say that the organisation facilitates their motivational profile We can say therefore that there is congruence between the 'motivational profile' of the individual and the 'motivational provisions' of the organisation However if the scientist is working in an organisation where they are constantly battling for resources, becoming involved in excessive administration work or working with unsatisfactory peers then

they will seek to satisfy their motivational profile elsewhere and hence not achieve high levels of research performance

As mentioned previously the term 'motivation profile' used here, refers to the individual scientists profile of motivational sources i e the sources of motivation that directs their behaviour These are facilitated by the 'motivational provisions' of the organisation, which refer to the degree to which the organisation can provide for the motivational sources of the scientists working there It is hypothesised that these motivational provisions are manifest in characteristics of the organisational research environment For example the motivational provision for the scientist's intrinsic process motive may be manifest in a positive work environment, with frequent and open communication with peers We could then hypothesize that providing that there is a match between the motivational profile of the scientist and the motivational provisions of the organisation the scientist will be effective

5 6 A new model of scientific effectiveness

The models presented in the following section represent the hypothetical relationship between the individual scientist's motivational profile and the organisational characteristics of the research organisation, and how this relationship relates to scientific effectiveness

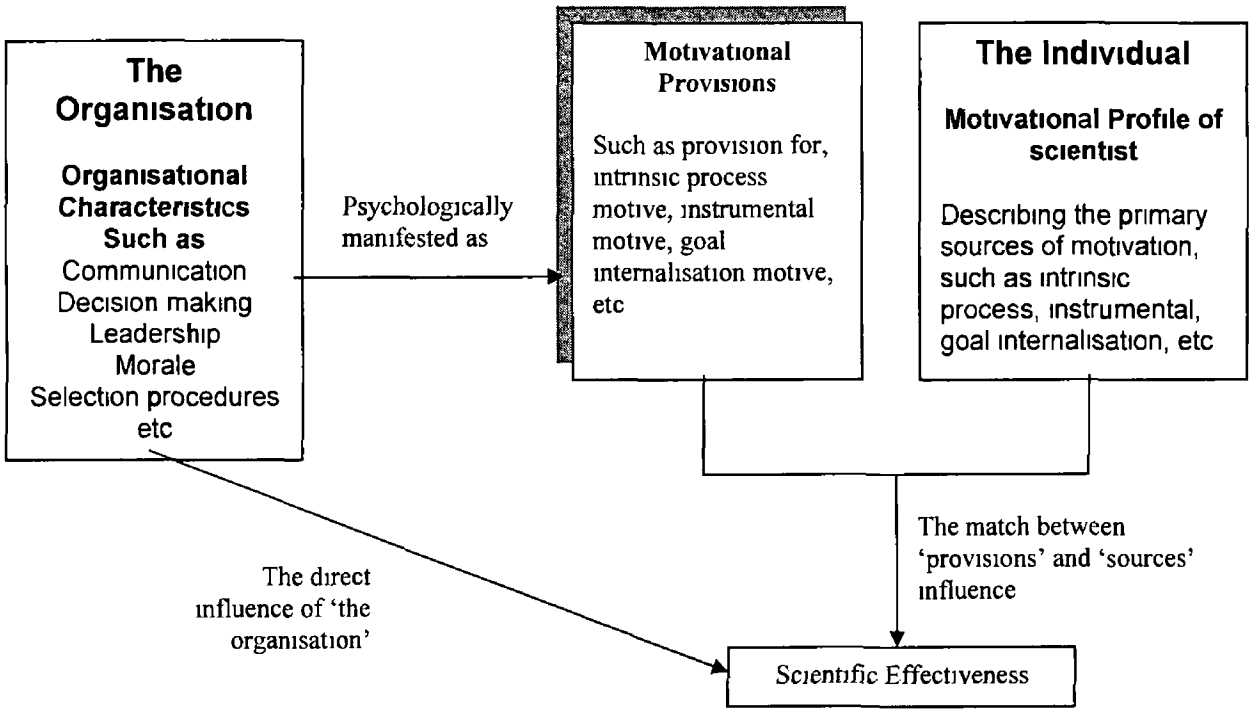


Figure 5 1 Organisational-Motivational model of scientific effectiveness

The model presented in figure 5 1 provides an illustration of the relationships to be examined in the current study On the extreme left-hand side we have 'The Organisation' which represents the characteristics of the research organisation which have been shown to be related to scientific effectiveness (Andrews, 1967, Argyris, 1968, Chawla & Singh, 1998, Hurley, 1997, Mouly & Sankaran, 1998, Pelz & Andrews, 1976, Thamhain & Wilemon, 1987, Unesco, 1979) The model then hypothesises that variation within these characteristics relates directly to the degree to

which an organisation 'provides' for the motivational needs of the scientists In this instance we can view the concept of 'Motivational Provisions' as the psychological manifestation of the influence that the research organisations characteristics have on the scientist (arrow A, figure 5 2a)

The concept of 'motivational provisions' presented here, stems primarily from the needs based perspectives of human motivation (Alderfer, 1972, Herzberg, 1968, Maslow, 1943, McClelland, 1961) This theoretical approach to motivation identifies the importance of the environment in facilitating or 'providing' for the satisfaction of motivational sources, and is consistent with Leonard et al's (1999) meta-theory of motivation As such the model presented here suggests that the physical and psychological conditions of the research organisation contributes directly to the scientists experience of whether their motivational sources are being met or not

In addition to this relationship the model recognises the fact that 'The Organisation' influences 'Scientific Effectiveness' directly, and so the model also illustrates a causal link directly from 'The Organisation' to 'Scientific Effectiveness' (arrow B) This is illustrated in figure 5 2a This proposed relationship stems directly from the management science perspectives of research on scientific effectiveness and the existing findings and propositions of researchers on the organisation of science (Argyris, 1968, Hurley, 1997, Mouly & Sankaran, 1998, Thamhain & Wilemon, 1987, Unesco, 1979) While not exclusively focusing on the processes of scientific research, much of this research highlights the bureaucratic needs of the scientific endeavour The scale and complexity of modern science necessitates the construction of bureaucracies to facilitate the action of science Scientists must be recruited,

trained, provided with adequate resources, communicate with peers, be provided with direction and leadership, be allowed to meet and plan experiments, etc This element of the organisation represents the bureaucratic necessities of scientific research Essentially this role of the characteristics of the research organisation reflects what Taylor (1911) might refer to as the scientific management of scientific research

However to view the role of the organisation of research from a purely bureaucratic or technocratic perspective would be to ignore the advances in organisational psychology that have been made since the human relations movement and beyond Consequently the current model recognises the bureaucratic role of the organisation in facilitating scientific effectiveness (as represented by arrow B, figure 5 2a) while also proposing that the characteristics of the research organisation influence more abstract psychological dimensions of the work setting In the current study the specific psychological concept under examination is the scientist's experience of the degree to which the organisation provides for their motivational needs (as represented by arrow A, figure 5 2a)

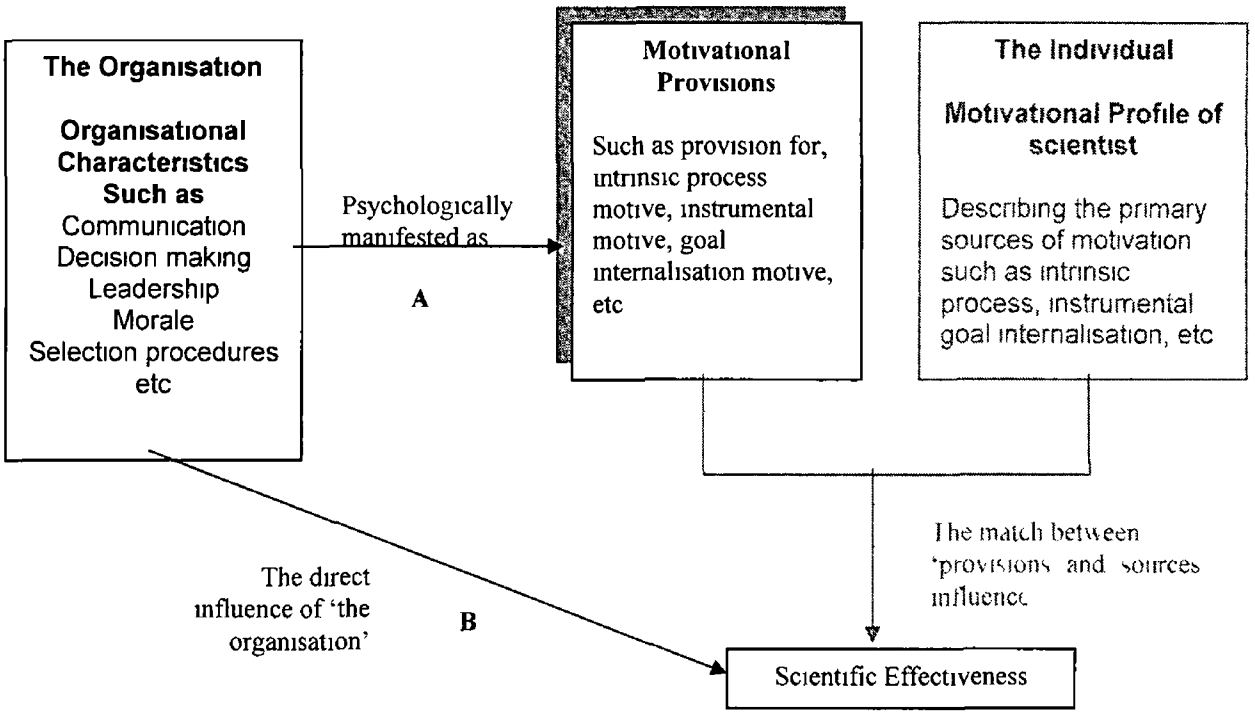


Figure 5 2a Organisational-Motivational model of scientific effectiveness highlighting the relationship between organisational characteristics and motivational provisions, and organisational characteristics and scientific effectiveness

On the extreme right-hand side of the model presented here we have the motivational sources as identified by Leonard et al (Leonard et al , 1999) The identification and measurement of these sources represents the 'Motivational Profile' of the scientist A crucial element of this model is the central interaction between the 'motivational provisions' of the research organisation and the 'motivational profile' of the individual scientist

The model hypothesises that when there is a match between the motivational sources of the individual, as identified by their 'Motivational Profile', and the 'Motivational Provisions' of the research organisation, the scientist will be effective in their research

(arrow C) Conversely any mismatch will result in reduced levels of effectiveness

This key relationship is illustrated in figure 5 2b

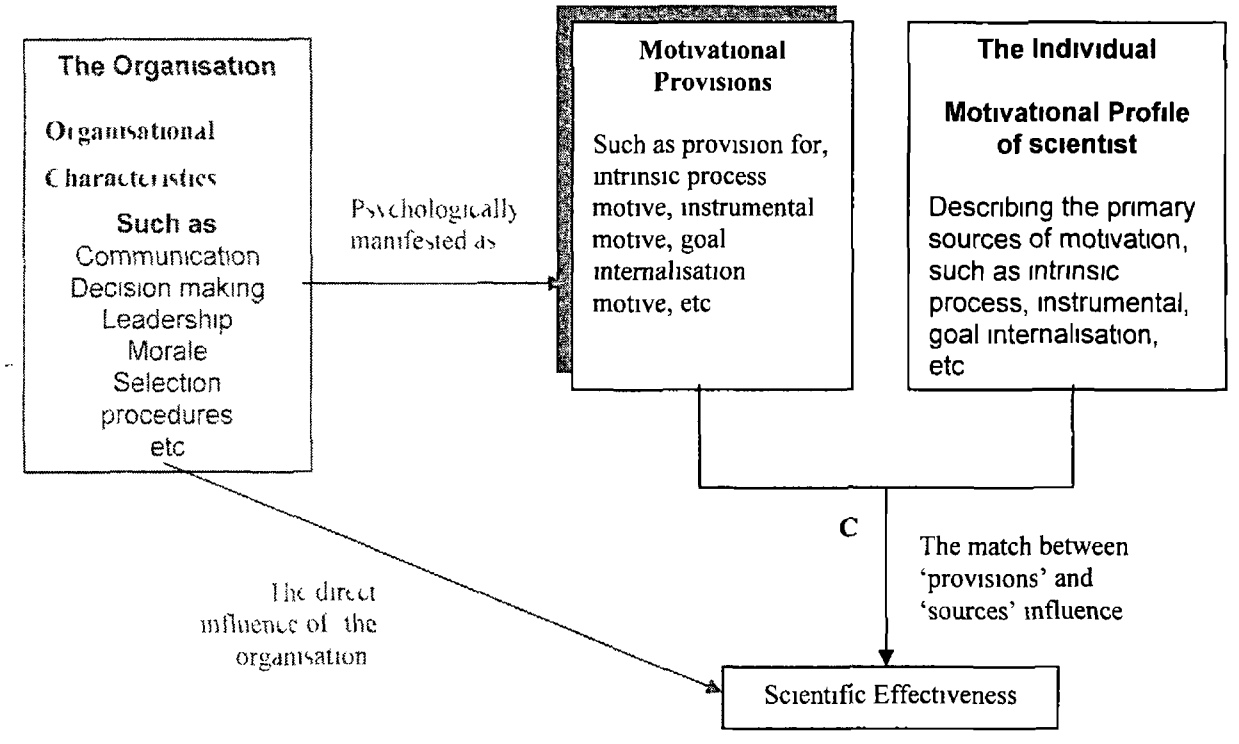


Figure 5 2b Organisational-Motivational model of scientific effectiveness highlighting the relationship between motivational sources and motivational provisions

To further clarify let us examine a hypothetical environment in which effective scientific research is taking place, as presented in figure 5 3 Within this hypothetical environment works a research scientist whose primary motivational source is Intrinsic process motivation, as defined by Leonard et al (1999) When faced with alternative tasks, individuals dominated by intrinsic process motivation will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable

Using a measurement instrument designed to measure the motivational concepts contained within Leonard et al's (1999) meta-theory of motivation our imaginary

scientist can be identified as being intrinsically motivated In addition to this an accompanying measure of the 'motivational provisions' of the research organisation also shows that intrinsic motivation is provided for by the research organisation Consequently there is a 'match' between the scientist source of motivation and the organisations provision for this type of motivation

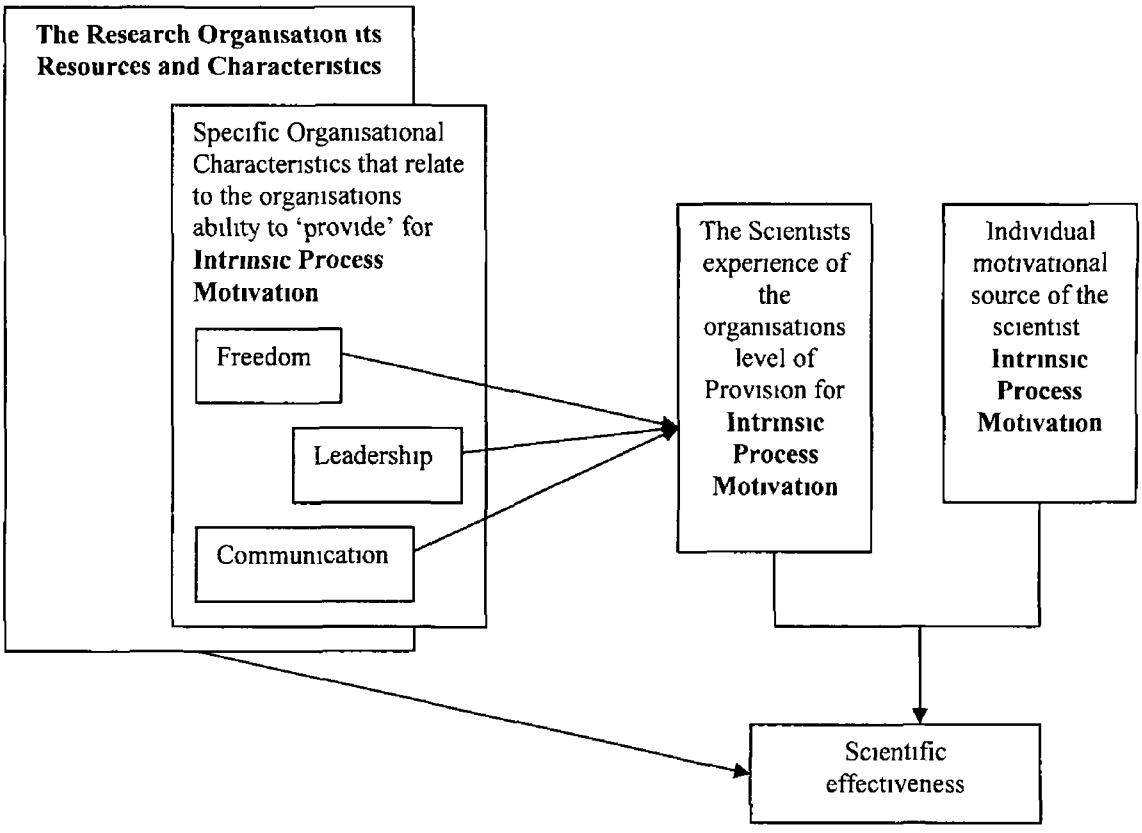


Figure 5 3 Illustration of hypothetical relationship between scientific effectiveness and the characteristics of the research organisation, the motivational provision of the research organisation for intrinsic process motivation, and the individual scientists level of intrinsic process motivation

Additional measures of environmental conditions within the research environment can also be used to identify which environmental factors relate specifically to the provision of the scientist motivational source In this hypothetical instance they are

'freedom' to choose their own research direction, positive 'communication' with their peers and colleagues, and a supportive 'leadership' style Figure 5 3 illustrates this hypothetical explanatory model of research effectiveness It explains how organisational characteristics such as freedom, communication, and leadership can influence the scientist's experience of how the organisation provides for their motivational needs It also predicts how the match between a scientists motivational needs and the degree to which the organisation meets those needs might influence scientific effectiveness

Figure 5 3 represents a specific example of the more generic relationship described in figure 5 1 While the model presented in figure 5 1 represents an explanatory theoretical model of how motivational concepts and organisational characteristics relate to scientific effectiveness, many of its constituent elements have yet to be examined through the research process For example, we do not know what a likely motivational profile for research scientists will look like, as one has not been constructed before Additionally we cannot say which organisational characteristics will relate to which motivational provisions as, to date, these relationships have not been examined

Consequently while the ultimate goal of this research is to explain the hypothesised relationship between the organisation, motivation and scientific effectiveness, it must first explore and describe the unknown elements contained within the model of scientific effectiveness presented in figure 5 1

In order to clarify and focus the direction of the current study a number of hypotheses and goals must first be stated The hypotheses stated here represent specific causal propositions derived from the model presented in figure 5 1 that are to be empirically tested The goals presented here represent clear and specific research perquisites that must be met in order to allow for the empirical evaluation of the relevant hypotheses Following are the three main hypotheses in the current study, as reflected in the models presented in figures 5 2a and 5 2b

Hypothesis one relates to the relationship between the characteristics of the research environment and level of research effectiveness within that environment This directional relationship suggests that the better the characteristics of the research environment, the more productive the research in that environment will be As mentioned previously this hypothesis is based on work that has examined the organisational characteristics that are believed to be necessary to foster and facilitate scientific effectiveness (Argyris, 1968, Hurley, 1997, Mouly & Sankaran, 1998, Thamhain & Wilemon, 1987, Unesco, 1979) These characteristics represent the essential bureaucracy of scientific research, the structures and processes that are necessary to ensure that scientific research can take place This is represented by arrow B in figure 5 2a

Hypothesis 1 'Research organisations that exhibit higher scores on measures of their organisational characteristics will exhibit higher scores on measures of research effectiveness'

The second hypothesis of the current study relates to the theorised relationship between the characteristics of the research environment and the motivational provisions of the organisation as perceived by the research scientists Figure 5 3 presents a hypothetical illustration of the relationship between the scientists reported levels of the organisations provision for Intrinsic process motivation and the specific characteristics of the research environment (in this case freedom, leadership and communication) A key aspect of the current study is the identification of the relationship between the organisations levels of motivational provision as reported by the scientist, and the organisational characteristics of the research environment Therefore hypothesis two reflects this theoretical proposition

Hypothesis 2 'The measurement of organisational characteristics of the research environment employed in the current study will relate directly to the measures of scientists experience of the organisations provision for motivational sources'

This hypothesis is illustrated by arrow A, figure 5 2a In this instance the characteristics of the research organisation are psychologically manifested as the scientist's experience of the degree to which the organisation provides for their motivational needs This hypothesis takes into account the degree to which the environment provides for motivational needs as proposed by the needs based perspectives of motivational theory (Alderfer, 1972, Herzberg, 1968, Maslow, 1943, McClelland, 1961)

Finally hypothesis three relates to the interaction between the scientists perceived provision for motivational sources by the organisation, and the actual level of

motivational sources of the scientist The model presented in Figure 5 2b theorises that the 'match' between these two concepts relates directly to the research effectiveness of the scientist Consequently hypothesis three reflects this theoretical proposition

Hypothesis 3 'The degree of fit between measures of the scientist's experience of the motivational provisions of the research organisation and measures of the scientist's motivational sources will correlate directly with measures of scientific effectiveness'

This hypothesis is represented by arrow C, figure 5 2b Essentially it describes the proposed relationship between the scientists' needs (i e 'motivational sources') and the degree to which those needs are met (i e 'motivational provisions') This hypothesis is based on the underlying theoretical propositions of the meta-theory of motivation (Leonard et al , 1999) Individuals will be motivated to perform tasks that allow them fulfil their motivational needs Consequently, provided that the activity of scientific research within a research organisation allows scientists to fulfil their motivational needs, scientists will engage in this activity and produce scientific outputs In essence they will be effective scientists

In addition to the three hypotheses presented above, there are a number of research goals that guide the current study The ability to test the hypotheses presented here depend on the attainment of these research goals These necessary goals can be categorised under the following concepts organisational characteristics, motivational provisions, motivational sources, and research effectiveness

Within the category of organisational characteristics there is a requirement for appropriate measurement of the organisational characteristics of the research environment Consequently research goal number one is

'The identification and measurement of organisational characteristics of the research environment that are believed to have an influence on scientific research effectiveness '

The concept of 'motivational provisions' is central to the model of research effectiveness presented in figure 5 2 A prerequisite for the examination of the current model of research effectiveness is the ability to measure the degree to which scientists perceive their motivational sources are being provided for, i e motivational provisions More specifically the motivational provisions being examined must relate conceptually to the Leonard et al (Leonard et al , 1999) motivational meta-theory that has been integrated into the current study Consequently research goal number two is

'The measurement of the degree to which scientists participating in the current study perceive their motivational sources are being provided for, i e their 'motivational provisions''

The concept of motivation in the current study contains two dimensions, motivational provisions, and motivational sources While the second goal of the current study is the identification of the scientist's motivational provisions, there is also an obvious need for the identification of the scientist's motivational sources Using the motivational theory of Leonard et al (1999) it should be possible to identify a motivational profile for each participating scientist across the five motivational concepts contained within

Leonard et al's (1999) meta-theory of motivation Consequently research goal number three is

'The measurement and construction of a motivational profile for research scientists'

The final element of the current study that requires further consideration is the measurement of scientific effectiveness As this is the key output of the model presented in figure 5 1 it is critical that appropriate measures of scientific effectiveness is employed in the current study Consequently research goal number four is

'The measurement of scientific research effectiveness for all scientists participating in the current study'

These goals in conjunction with the research hypotheses presented previously represent clear guides for the structure and design of the current study What follows in chapter six is a description of the procedures employed in the selection and, where necessary, development of measurement instruments required for the operationalisation of key concepts contained within the model presented in figure 5 1

CHAPTER SIX

THE DEVELOPMENT AND SELECTION OF MEASUREMENT INSTRUMENTS FOR USE IN THE CURRENT STUDY

6 1 Introduction

The hypotheses and goals presented in chapter five require the operationalisation of several key concepts contained within the model presented in figure 5 1 These concepts include the organisational environment in which scientists' work, a scientists sources of motivation, a measure of the scientist's experience of how their motivations are met by the work environment, and finally the concept of scientific effectiveness The following chapter describes the selection of measurement instruments used to operationalise the concepts mentioned above It also describes the development of new instruments where suitable pre-existing instruments could not be found

6.2 Measuring motivations

The meta-theory of motivation proposed by Leonard, Beauvais and Scholl (1999) provides a contemporary integration of classical motivational theories with recent research on the 'self-concept' As such it offers a useful insight into the role of motivation in influencing behaviour The main drawback of incorporating this meta-theory of motivation into the current study is the lack of existing measurement instruments that adequately operationalise the concepts contained within the theory

6.2 1 The motivational source inventory (MSI)

In order to utilise the meta-theory of motivation developed by Leonard, Beauvais and Scholl (1999) it was necessary to identify a suitable measurement instrument that operationalised the motivational concepts within the theory At the time when the current research study was conducted only one measurement instrument was in existence The instrument in question, the Motivational Source Inventory (MSI), was developed by Barbuto and Scholl (1998) The authors of the MSI generated a list of 78 potential items for their measurement scales based on the theoretical definitions of the factors within Leonard et al's meta-theory of motivation These definitions are presented below

Intrinsic process motivation

When faced with alternative tasks, individuals dominated by intrinsic process motivation will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable

Instrumental motivation

When faced with alternative tasks, individuals dominated by instrumental motivation will engage in the task that provides the greatest potential for extrinsic rewards, and the behaviour will be sustained as long as the likelihood of attaining those rewards remains

External Self-concept motivation

When faced with alternative tasks, individuals dominated by external self-concept based motivation will engage in tasks that provide them with affirmative social

feedback relative to others, concerning their traits, competencies, and values in their important identities Behaviour will be sustained as long as relative, positive social feedback is forthcoming

Internal Self-concept motivation

When faced with alternative tasks, individuals dominated by internal self-concept based motivation will engage in tasks that provide them with affirmative task feedback about their traits, competencies and values in their important identities Behaviour will be sustained as long as positive task feedback is forthcoming

Goal Internalization motivation

When faced with alternative tasks, individuals dominated by goal-internalization motivation will choose to engage in tasks that have the greatest potential of achieving the groups or organisations goals Behaviour will be sustained as long as progress towards those goals continues

The 78 statements, relating to the definitions above, generated by Barbuto and Scholl (1998) were then evaluated by experts familiar with the constructs for conformity to the theoretical definitions and for redundancy 74 items were retained for assessment The content validity of the MSI was assessed by subjecting the 74 items of the instrument to the examination by two independent panels of judges (N=32 and N= 37) Barbuto and Scholl (1998) then presented the judges (all students in organisational behaviour) with the construct definitions and asked them to classify the randomly ordered items into one or more sources of motivation Items that were assigned to the proper *a priori* category more that 60% of the time were retained

The 60 retained items were then administered to a sample of 156 undergraduate students, who were asked to indicate the extent of their agreement with each statement on a 7 point Likert scale These results were then factor analysed Barbuto and Scholl (1998) report that the varimax-rotated component pattern for the five subscales showed five factors with at least six unique items per subscale A confirmatory factor analysis was then performed on the 30 remaining items A LISREL maximum likelihood confirmatory factor analysis revealed a goodness of fit of the factor structure to be 92 The general characteristics of the subscales as reported by Barbuto and Scholl (1998) are listed in table 6 2 1

Table 6 2 1 General characteristics of MSI subscales

SUBSCALE	M	SD	COEFFICIENT α
Intrinsic Process	23 8	6 9	92
Instrumental	26 8	8 5	83
External Self-concept	26 9	5 6	85
Internal Self-concept	30 9	7 3	90
Goal Internalization	25 8	7 9	88

Despite the apparent statistical strength of the MSI as reported by Barbuto and Scholl (1998) a cursory investigation of the face validity of the instrument suggested some potential difficulties In addition to this the author of the current study was concerned about the sample of participants that were employed by Barbuto and Scholl (1998) to validate the instrument, and the relation of those participants to the participants of the current study

In order to alleviate any concerns about the instrument and identify any potential problems with the instrument in advance, it was decided that a reliability analysis should be carried out

6 2 2 Reliability analysis of the MSI

A hard copy of the MSI was sent to 76 research academics in the Dublin City University Business School, Physics Department and Biotechnology Department, via the internal mail system These participants were chosen to take part in the reliability analysis because of their similarity to the group of research scientists who would take part in the main data collection phase of the current study 43 research academics completed and returned the questionnaire Giving a response rate of 56 58% A Cronbach alpha reliability analysis was conducted on each of the five factors of the MSI Results are presented in table 6 2 2 below

Table 6 2 2 General characteristics of MSI subscales derived from reliability analysis

SUBSCALE	M	SD	COEFFICIENT α
Intrinsic Process	23 4	4 9	4563
Instrumental	24 2	4 8	4924
External Self-concept	26 7	5 7	6876
Internal Self-concept	37	3	6177
Goal Internalization	28 6	5 6	7053

As can be seen from table 6 2 2 the Cronbach alpha reliabilities reported in the analysis were considerably weaker than those reported by Barbuto and Scholl (1998) which have been presented in table 6 2 1 Only one subscale, Goal Internalization, was above the recommended Cronbach alpha value of 0 7 for reliability of instruments for use m research In addition to these results the author of the current study also conducted a re-evaluation of raw MSI data collected by Evans (2001) The

results of this analysis also confirmed the weak scale reliabilities of the MSI These finding in addition to initial concerns over the face validity of the MSI suggested that it would not be suitable for use in the current study

Though the MSI was judged to be unsuitable for use in the current study a measurement instrument for the concepts contained within Leonard et al's (1999) meta-theory of motivation was required Consequently further analysis was conducted on the MSI to facilitate the construction of a modified and revised measurement instrument for the motivational factors of Leonard et al's (1999) meta-theory

The following section presents analyses and modifications for each of the individual subscales in Barbuto and Scholl's (1998) MSI In order to identify the exact components that were contributing to the weak reliability scores of the MSI an inter-item correlation matrix, and scale if item deleted statistic were conducted for each of the subscales

6 3 The analysis and modification of the MSI

Following is a description of the steps taken in analysing and modifying the MSI This was done to facilitate the development of a more suitable measurement instrument, capable of operationalising the concepts contained within Leonard et al's (1999) meta-theory of motivation In addition to the statistical analyses conducted on the MSI, research was also conducted on the construction and identification of scale items that would be suitable for use in a new measurement instrument This new measurement instrument is hitherto referred to as the Measure of Motivational

Sources beta (MMS BETA) The term 'BETA' is used in this context to highlight the fact that the MMS exists in a developmental stage It is a term commonly used in computer programming to denote a software programme that has not been completely debugged or whose integrity has not been confirmed The use of this term also allows the reader to distinguish between the instrument developed for use in the current study in its initial stages of development (MMS BETA) and a more finalised version employed in the main data collection phase of the current study which is simply referred to as the MMS

Several approaches were taken in the construction and identification of new items for use in the MMS BETA For example, a questionnaire was sent to a meeting of senior work and organisational psychologists from the European Network of Work and Organisational Psychologists (ENWOP) in Paris The ENWOP group is a network of Professors of organisational psychology from European universities and research institutes Their understanding and interpretation of the concepts contained within the meta-theory of motivation was valuable due to their position as recognised experts in the area of organisational psychology

The ENWOP participants were asked to write in their own words what they understood by Leonard et al' (1999) five descriptors of the motivational sources contained within the meta-theory This information was then used to examine the level of consistency of understanding of the concepts, and also to determine what words and phrases might be conceptually related to the motivational constructs This questionnaire and the data gathered from it are presented in appendix A1 and appendix A2 respectively

Additionally, several other measures of work motivation were examined to determine if suitable scale items or terms could be incorporated from them These measurement instruments included the Internal Work Motivation Scale (Cammann, Fichman, Jenkins, & Klesh, 1983, Mossholder, Kemery, Harris, & Armenakis, 1994), the Achievability of Future Goals Scale (Savickas & Jarjoura, 1991), the Achievement Motivation Scale (Mathieu, 1991, Steers & Braunstein, 1976), the Affinity-Seeking Scale (McCroskey & McCroskey, 1986, Prisbell, 1994), the Goal Commitment Scale (Barrick, Mount, & Strauss, 1993, Hollenbeck, Klein, O'Leary, & Wright, 1989), the Job Desirability Exercise (Butler & Stahl, 1993), and the Pay Valance Scale (Fox, Geyer, & Donohue, 1994)

Where appropriate modifications were also made to existing Motivational Source Inventory items to improve their suitability These modified items where then retained for used in the Measure of Motivational Sources BETA

6 3 1 Analysis and modification of the intrinsic process motivation subscale

The Intrinsic process motivation subscale was designed to measure the degree to which an individual is motivated by a sense of enjoyment in what they do According to proposition six of Leonard et al (1999) meta-theory of motivation, When faced with alternative tasks, individuals dominated by intrinsic process motivation will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable Presented in table 6 3 1 is a list of the scale items that make up the subscale of Intrinsic Process Motivation

Table 6 3 1 MSI scale items for Intrinsic process motivation (Barbuto & Scholl, 1998)

ITEM NO	STATEMENT
06	I only like to do things that are fun
11	If I didn't enjoy doing my job at work I would leave
16	I often put off work so that I can do something else that is more fun
18	If choosing between two jobs, the most important criterion is 'which is more fun?'
21	When choosing jobs I usually choose the one that sounds like the most fun
27	The people I choose to spend my time with are the most fun to be with

As shown in table 6 2 2 The Cronbach alpha reliability of this subscale was found to be 0 4563, which is considerably lower than the 0 92 reported by Barbuto and Scholl (1998), and suggests that this particular subscale would be unsuitable for use in the current study A cursory examination of the 'scale if item deleted' statistic presented in table 6 3 2 indicates that the removal of items 11, and 16 would lead to a significant improvement in the Cronbach alpha score for this subscale Though it would still fall below the 0 7 minimum recommended for research purposes

Table 6 3 2 Alpha if item deleted statistic for Intrinsic process motivation subscale

ITEM NO	ALPHA IF ITEM DELETED
06	2789
11	5827
16	5566
18	3224
21	2278
27	3848

A further examination of the correlation matrix for the Intrinsic Process Motivation subscale clearly shows that items 11 and 16 do not correlate well with the other items of the subscale (see table 6 3 3) In fact the inter-correlation of nearly all items within

this subscale are at such a low level that it would seem the subscale as a whole was unsuitable and in need of significant modification

Table 6 3 3 Correlation matrix for Intrinsic process motivation subscale

ITEM	06	11	16	18	21	27
06	1 0000					
11	2296	1 0000				
16	0730	- 3532	1 0000			
18	2596	- 2188	1586	1 0000		
21	3256	- 1189	3365	5982	1 0000	
27	3086	2127	- 2521	2436	2597	1 000

An examination of the content of the items presented in table 6 3 1 highlights some of the potential reasons for the weakness of the subscale For example item 11 'If I didn't enjoy doing my job at work I would leave ' While a person who is intrinsically process motivated may well consider such an act, they may not always engage in it A lack of alternative employment opportunities may force an individual to stay in an employment position they are not happy with Financial commitments and economic concerns could be strong mediating factors against a person leaving a job despite their unhappiness

Item 16, 'I often put off work so that I can do something else that is more fun', may also be ambiguous to some respondents For example, this statement suggests that work is not fun Yet many people get great enjoyment from their work and might consequently have great difficulty answering such a question An individual who finds nothing more enjoyable than their work would strongly disagree with the statement in item 16 This response would then be interpreted as a lack of intrinsic motivation when in fact the opposite would be true

A further potential problem with the items of the intrinsically process motivated subscale is the use of the word 'fun' in all but one of the items. It is possible that the word 'fun' used within an American context may not have the same meaning in a Northern European context. For example a research scientist may gain great enjoyment from conducting their research. Overcoming difficult problems, developing new and innovative research techniques, and analysing unexpected results may all contribute to a thoroughly enjoyable experience for the researcher. However the use of the word 'fun' in this context, may bring with it connotations of carelessness and frivolity that may seem inappropriate in the research laboratory. Consequently 'enjoyable' may be a more suitable word than 'fun'. In fact it is 'enjoyable' that is used by Leonard et al (2000) in their proposition to describe an individual who is motivated by intrinsic processes.

Presented in table 6.3.4 are the revised items for inclusion in the MMS BETA subscale of Intrinsic process motivation. As mentioned previously these items were developed from modifications to existing MSI items, analysis of information gathered from the ENWOP group, and analysis of scale items from other motivation measures.

Table 6.3.4 Items for Intrinsic process motivation subscale of the MMS BETA.

MMS1	It is important that the work I do gives me a sense of enjoyment.
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS3	I would rate 'enjoyment' very highly among reasons why someone should do a job.
MMS4	I would rather enjoy life than worry about the consequences of my behaviour.
MMS5	If a job were not enjoyable then I'd rather not do it.
MMS6	If something is not enjoyable then it is not worth doing.
MMS7	I think being able to enjoy your work is more important than anything else.
MMS8	I would only do a job if I found it enjoyable.

6 3 2 Analysis and modification of the Instrumental motivation subscale

The Instrumental motivation subscale was designed to measure the degree to which an individual is motivated by the potential for extrinsic rewards According to proposition seven of Leonard et al (1999) meta-theory of motivation, When faced with alternative tasks, individuals dominated by instrumental motivation will engage in the task that provides the greatest potential for extrinsic rewards, and the behaviour will be sustained as long as the likelihood of attaining those rewards remains Presented in table 6 3 5 is a list of the scale items that make up the subscale of Instrumental motivation

Table 6 3 5 MSI scale items for Instrumental motivation (Barbuto & Scholl, 1998)

ITEM NO	STATEMENT
01	People should always keep their eyes and ears open for better job opportunities
07	Job requirements dictate how much effort I exert during work
12	A day's work for a day's pay
17	I would work harder if I knew that my effort would lead to higher pay
22	When choosing jobs I usually choose the one that pays the most
30	At work, my favourite day of the week is 'payday'

As shown in table 6 2 2 The Cronbach alpha reliability of this subscale was found to be 0 4924, which is considerably lower than the 0 83 reported by Barbuto and Scholl (1998), and suggests that this particular subscale would be unsuitable for use in the current study A cursory examination of the 'scale if item deleted' statistic presented in table 6 3 6 does not provide any clear indication of particularly poor items, though the removal of items one and seven would increase the reliability of the subscale somewhat

Table 6 3 6 Alpha if item deleted statistic for Instrumental motivation subscale

ITEM NO	ALPHA IF ITEM DELETED
01	5500
07	5432
12	4384
17	4204
22	3619
30	3014

A further examination of the correlation matrix for the Instrumental Motivation subscale highlights the clear statistical weaknesses of this subscale (see table 6 3 7) In fact the inter-correlation of nearly all items within this subscale are at such a low level that it would appear that the items of this scale are predominantly unrelated

Table 6 3 7 Correlation matrix for Instrumental motivation subscale

ITEM	01	07	12	17	22	30
01	1 0000					
07	- 2752	1 0000				
12	0033	3133	1 0000			
17	0624	- 1239	1671	1 0000		
22	1005	0442	0599	4071	1 0000	
30	0874	1916	1331	3331	5028	1 000

An examination of the content of the items of this subscale presented in table 6 3 5 highlight some of the potential weakness of the subscale For example in item one the concept of extrinsic motivation seems unclear Perhaps if the phrase 'better job opportunities' was more specific it may be more relevant A 'better job opportunity' does not directly imply a better-paid job Depending on the individuals perception it may mean a job that gives them more stability or greater flexibility, is more enjoyable or gives them more free time The relationship between better job opportunities and greater financial reward and promotional prospects is by no means implicit

Similarly, the relationship between extrinsic motivation and item seven of this scale is unclear There may be a vicarious link between extrinsic reward, job requirements and motivation, but based on the statistical analysis, this item does not seem to be related to the concept of extrinsic reward

Again in item 12 we are presented with another ambiguous statement Responses to a statement such as 'A day's work for a day's pay' would seem to be related more to concepts of social justice or employment equality than to the concept of extrinsic motivation

As a consequence of these weaknesses the current MSI subscale for Instrumental motivation was deemed to be unsuitable for use in the current study An alternative subscale for measuring the concept of Instrumental motivation was constructed as part of the MMS BETA The items of this subscale were developed with reference to the information gathered from the ENWOP group referred to previously, and following reference to alternative motivational measurement instruments referred to in section 6 3 Where possible, the original MSI items were retained The items that make up the subscale of Instrumental motivation for the MMS BETA are presented in table 6 3 8

Table 6 3 8 Items for Instrumental motivation subscale of the MMS BETA

MMS9	People should always be on the lookout for better-paid jobs
MMS10	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS11	I would only work harder if I knew my effort would lead to greater financial reward
MMS12	The best aspects of any job are the financial rewards and associated financial benefits
MMS13	I only work for the financial reward that it provides me
MMS14	I would readily leave any job if I were offered an alternative that pays more
MMS15	The day I look forward to most m my job is 'pay-day'
MMS16	I really only work for the money

6 6 3 Analysis and modification of the External Self-concept motivation subscale

The External Self-concept motivation subscale was designed to measure the degree to which an individual is motivated by tasks that provide them with affirmative social feedback relative to others, concerning their traits, competencies, and values in their important identities According to proposition eight of Leonard et al's (1999) meta-theory of motivation, When faced with alternative tasks, individuals dominated by external self-concept based motivation will engage in tasks that provide them with affirmative social feedback relative to others, concerning their traits, competencies, and values in their important identities Behaviour will be sustained as long as relative, positive social feedback is forthcoming Presented in table 6 3 9 is a list of the scale items that make up the subscale of External Self-concept Motivation

As shown in table 6 2 2 the Cronbach alpha reliability of this subscale was found to be 0 6876, which is considerably lower than the 0 85 reported by Barbuto and Scholl (1998)

Table 6 3 9 MSI scale items for External Self-concept motivation (Barbuto & Scholl, 1998)

ITEM NO	STATEMENT
03	It is important to me that others approve of my behaviour
08	I often make decisions based on what others will think
19	I work harder on a project if public recognition is attached to it
23	If choosing jobs I want one that allows me to be recogmsed for successes
25	Those people who make the most friends have lived the fullest lives
29	I give my best effort when I know that it will be seen by the most influential people in an organisation

Although the reliability of this scale was found to be lower than originally reported by the developers it is only marginally lower than the Cronbach alpha score of 0 7 which is generally agreed as an acceptable level of reliability for scales used for research purposes However to ensure its suitability, further analysis of the subscale was conducted to determine if improvements could be made A cursory examination of the 'scale if item deleted' statistic presented in table 6 3 10 indicates that the removal of item 25 would significantly increase the reliability of the subscale It also indicates that item 23 may be contributing to the poor reliability of the instrument

Table 6 3 10 Alpha if item deleted statistic for External Self-concept motivation subscale

ITEM NO	ALPHA IF ITEM DELETED
03	3120
08	6076
19	6199
23	6989
25	7567
29	5246

A further examination of the correlation matrix for the External Self-concept Motivation subscale highlights the poor relationship between item 25 and the other

items of the scale and also the weak relationship between item 23 and the remaining items of the subscale (see table 6 3 11)

Table 6 3 11 Correlation matrix for External Self-concept motivation subscale

ITEM	03	08	19	23	25	29
03	1 0000					
08	6094	1 0000				
19	2826	4681	1 0000			
23	0987	- 1107	2496	1 0000		
25	0177	- 0974	0215	2766	1 0000	
29	5490	6333	5221	2127	1889	1 000

In order to understand and explain the potential causes of the weaknesses in the External Self-concept subscale the content of items of the subscale were examined As we can see from table 6 3 9 item 25, ('Those people who make the most friends have lived the fullest lives'), looks somewhat out of place among the other statements relating to external self-concept In this instance the relationship between quantity of friendships and the need for affirmative social feedback is not obvious or indeed strong Certainly being motivated by external self-concept processes may affect the nature of friendships or indeed the types of friends an individual may choose but its relation to the quantity of friendships is dubious

As mentioned previously some doubt was expressed over the suitability of item 23 ('If choosing jobs I want one that allows me to be recognised for successes') The idea of receiving recognition for achievements is strongly related to the external self-concept Such recognition relates strongly to affirmative social feedback However, it is possible that respondents interpreted this statement as relating to attention seeking

rather than simply recognition, which may have influenced their scoring of the item The item may therefore be suitable for use with some modification

In addition to this it was also felt that item three 'It is important to me that others approve of my behaviour' should be modified to concentrate more specifically on 'work behaviour' This would strengthen the focus of the instrument on the organisational setting

As we have seen several of the items of the subscale for External Self-concept motivation correlate well and require no modification However due to overall weakness of the scale and its poor reliability coefficient some modifications and additions were made in an attempt to provide improvement A modified subscale for measuring the External Self-concept motivation was constructed as part of the MMS BETA The items of this subscale were developed with reference to the information gathered from the ENWOP group and several alternative motivational measurement instruments referred to previously Where prudent the original MSI items were retained The items that make up the subscale of Instrumental motivation for the MMS BETA are presented in table 6 3 12

Table 6 3 12 Items for External Self-concept motivation subscale of the MMS BETA

MMS17	It is important to me that my colleagues should approve of my work behaviour
MMS18	The recognition of ones colleagues is the most important reward for a job well done
MMS19	I work harder on a project if public recognition is attached to it
MMS20	People should work hard for the respect and admiration of their peers
MMS21	I often make decisions based on what others will think
MMS22	I work harder when I know others are evaluating my work
MMS23	I give my best effort when I know that it will be seen by the most influential people in an organisation
MMS24	When I have done a good job it is important to me that my contribution is recognised by others

6 3 4 Analysis and modification of the Internal Self-concept motivation subscale

The Internal Self-concept motivation subscale was designed to measure the degree to which an individual is motivated by affirmative task feedback about their traits, competencies and values in their important identities According to proposition nine of Leonard et al (1999) meta-theory of motivation, When faced with alternative tasks, individuals dominated by internal self concept based motivation will engage in tasks that provide them with affirmative task feedback about their traits, competencies and values in their important identities Behaviour will be sustained as long as positive task feedback is forthcoming Presented in table 6 3 13 is a list of the scale items that make up the subscale of Internal Self-concept motivation

As shown in table 6 2 2 The Cronbach alpha reliability of this subscale was found to be 0 6177, which is considerably lower than the 0 9 reported by Barbuto and Scholl (1998)

Table 6 3 13 MSI scale items for Internal Self-concept motivation (Barbuto & Scholl, 1998)

ITEM NO	STATEMENT
02	I need to know that my skills and values are impacting organisation's success
04	Decisions I make will reflect high standards that I've set for myself
09	It is important that I work for a company that allows me to use my skills and talents
13	I try to make sure that my decisions are consistent with my personal standards of behaviour
15	I like to do things which give me a sense of personal achievement
28	I consider myself a self-motivated person

As a result of this disparity and low Cronbach alpha score it was decided that the subscale for Internal Self-concept motivation would require some modification if it was to be used in the current study In order to identify specific items that may have contributed to the poor alpha score of the scale an examination of the alpha if item deleted statistic was undertaken for the subscale (see table 6 3 14)

Table 6 3 14 Alpha if item deleted statistic for Internal Self-concept motivation subscale

ITEM NO	ALPHA IF ITEM DELETED
02	6642
04	5615
09	5559
13	5211
15	5717
28	5688

As can be seen from table 6 3 14 the only item, which, if deleted, improves the reliability of the scale, is item 02 'I need to know that my skills and values are impacting organisation's success' A further examination of the correlation matrix for the Internal Self-concept motivation subscale was undertaken to determine other

potential weaknesses that may have contributed to the subscales poor reliability (See table 6 3 15)

Table 6 3 15 Correlation matrix for Internal Self-concept motivation subscale

ITEM	02	04	09	13	15	28
02	1 0000					
04	0300	1 0000				
09	2937	2404	1 0000			
13	2243	4968	2296	1 0000		
15	1941	1348	4421	2095	1 0000	
28	0211	3441	2476	3811	3061	1 000

As can be seen from table 6 3 15 item 02 correlates quite poorly with the other items in the scale However the removal of this item alone does not sufficiently improve the reliability of the subscale In addition to the weakness of item 02 within the subscale we can also see weak inter-correlation's between other items For example items 04 and 15 are poorly correlated, as well as items 15 and 13

Based on the statistical analysis of the reliability study for the MSI it became clear that significant modification of the instrument would be required prior to its use in the current study A modified subscale for measuring the Internal Self-concept motivation was constructed as part of the MMS BETA The items of this subscale were developed with reference to the information gathered from the ENWOP group and alternative motivational measurement instruments referred to previously Where possible the original MSI items were retained The items that make up the subscale of Instrumental motivation for the MMS BETA are presented in table 6 3 16

Table 6 3 16 Items for Internal Self-concept motivation subscale of the MMS BETA

MMS25	It is important that I work in a job that allows me to use my skills and talents
MMS26	When choosing between jobs the most important criterion is 'which will provide me with a greater sense of personal achievement'?
MMS27	I consider myself a self-motivated person
MMS28	It is important that I work in a job that allows me to realise my potential
MMS29	Decisions I make reflect the high standards that I set for myself
MMS30	I get great personal satisfaction from doing a job well
MMS31	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour
MMS32	I like to do work that challenges me and gives me a sense of personal achievement

6 3 5 Analysis and modification of the goal internalization motivation subscale

The Goal Internalization motivation subscale was designed to measure the degree to which an individual is motivated by tasks that have the greatest potential of achieving the groups or organisations goals According to proposition ten of Leonard et al's (1999) meta-theory of motivation, When faced with alternative tasks, individuals dominated by goal-internalization motivation will choose to engage in tasks that have the greatest potential of achieving the groups or organisations goals Behaviour will be sustained as long as progress towards those goals continues Presented in table 6 3 17 is a list of the scale items that make up the MSI subscale of Goal Internalization Motivation

As shown in table 6 2 2 The Cronbach alpha reliability of this subscale was found to be 0 7053, which is somewhat lower than the 0 88 reported by Barbuto and Scholl (1998)

Table 6 3 17 MSI Scale Items for Goal Internalization Motivation

ITEM NO	STATEMENT
05	I would not work for a company if I didn't agree with its mission
10	I have to believe in a cause before I will work hard at achieving its ends
14	Unless I believe in a cause, I will not work hard
20	When choosing an organisation to work for, I look for one that supports my beliefs and values
24	An organisation's mission needs to be in agreement with my values for me to work hard
26	If an organisation is accomplishing missions that I agree with, it doesn't matter whether I was responsible for its success

Although the Cronbach alpha reported here is at an acceptable level the disparity between this score and the original scale reliability reported by Barbuto and Scholl (1998) suggested that an examination of the items of the scale may be beneficial to determine if any improvements could be made In order to identify specific items, which may have contributed to the lower alpha score of the scale an examination of the alpha if item deleted statistic, was undertaken for the subscale (see table 6 3 18)

Table 6 3 18 Alpha if item deleted statistic for Goal Internalization motivation subscale

ITEM NO	ALPHA IF ITEM DELETED
05	6637
10	6517
14	6396
20	7029
24	5985
26	7171

As can be seen from table 6 3 18 the only item, which, if deleted, improves the reliability of the scale, is item 26 'If an organisation is accomplishing missions that I agree with, it doesn't matter whether I was responsible for its success' A further examination of the correlation matrix for the Goal Internalization motivation subscale

was undertaken to determine other potential weaknesses that may be have contributed to the subscales reduced reliability (see table 6 3 19)

Table 6 3 19 Correlation matrix for Goal Internalization motivation subscale

ITEM	05	10	14	20	24	26
05	1 0000					
10	1461	1 0000				
14	3408	2404	1 0000			
20	4813	0924	0473	1 0000		
24	3111	5860	4989	2493	1 0000	
26	2392	1059	1089	1961	2418	1 000

Of all the items in the subscale item 26 correlates quite poorly with the other items in the scale However the removal of this item alone does not sufficiently improve the reliability of the subscale In addition to the weakness of item 26 within the subscale we can also see weak inter-correlations between other items For example items five and ten are poorly correlated, as are items ten and 20 and ten and 26 as well as items 14 and 20

Based on the statistical analysis of the reliability study for the MSI it was decided that some modification of the instrument would be required prior to its use in the current study A modified subscale for measuring the concept of Goal Internalization motivation was constructed as part of the MMS BETA The items of this subscale were developed with reference to the information gathered from the ENWOP group and several alternative motivational measurement instruments referred to previously Where prudent the original MSI items were retained The items that make up the subscale of Instrumental motivation for the MMS BETA are presented in table 6 3 20

Table 6 3 20 Items for Goal Internalization motivation subscale of the MMS BETA

MMS33	I would find it very difficult to work for an organisation if I didn't agree with its missions and goals
MMS34	I have to believe in a cause before I will work hard at achieving its ends
MMS35	Unless I believe in a cause, I will not work hard for it
MMS36	When choosing an organisation to work for, I look for one that supports my beliefs and values
MMS37	An organisation's mission needs to be in agreement with my values for me to work hard
MMS38	I would work harder on a project if I believed in its mission and goals
MMS39	It is important to me that the goals of the organisation I work for are congruent with my personal goals
MMS40	I am unconcerned with personal recognition once the goals of the group I work with are achieved

6 4 The Measure of Motivational Sources and Measure of Motivational Provisions

As mentioned at the beginning of this chapter several instruments were required to operationalise and measure the concepts contained within the theory of research effectiveness developed during this study Two separate and conceptually distinct motivational measures were required The first instrument was needed to measure the profile of motivational sources of participants, i e to identify what motivates scientists in their work The development of this instrument (The Measure of Motivational Sources BETA) has been described in the previous section

The other motivational measure required for the current study relates to scientists experience of how the motivational concepts of Leonard et al's (1999) meta-theory are provided for by their work environment While the MMS BETA asks scientists to reflect on their personal beliefs and behaviours in relation to the various motivational

concepts of the meta-theory, the Measure of Motivational Provisions (MMP) requires scientists to reflect and report on their concrete experience of their work environment In recognition of the initial stage of development of the measurement instrument discussed in this section the term 'beta' will again be used in the naming of the instrument

The Measure of Motivational Provisions Beta (MMP BETA) is essentially a measure of the degree to which the work setting provides participants with the conditions necessary for the satisfaction of the motivational sources contained within Leonard et al's (1999) meta-theory of motivation

Therefore in order to construct the necessary measure, close attention was paid to the original statements of the MMS BETA Where possible, concrete statements linked directly to MMS BETA statements, but also relating to the specific nature of the scientists work environment were constructed In some instances it was not possible to construct a MMP BETA statement that related directly to an MMS BETA statement In these instances alternative MMP BETA statements were constructed which reflected the motivational concept in question and related that concept to an aspect of the concrete work environment

The 40 original items of the MMS BETA and the newly developed items of the MMP BETA are presented in the following tables Original MMS BETA items are presented in these tables to illustrate how the newly developed MMP BETA items relate to the motivational constructs of Leonard et al's (1999) meta-theory of motivation

Table 6 4 1 Items for Intrinsic process motivation subscale of the MMS BETA and MMP BETA

MMS1	It is important that the work I do gives me a sense of enjoyment	MMP1	The work I do in my current job gives me a sense of enjoyment
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'	MMP2	I do this job because I enjoy the work
MMS3	I would rate 'enjoyment' very highly among reasons why someone should do a job	MMP3	I get a sense of enjoyment from the activities I engage in, in this job
MMS4	I would rather enjoy life than worry about the consequences of my behaviour	MMP4	I find the work I do in this organisation enjoyable
MMS5	If a job were not enjoyable then I'd rather not do it	MMP5	I enjoy the work I do here
MMS6	If something is not enjoyable then it is not worth doing	MMP6	The work I do here is enjoyable
MMS7	I think being able to enjoy your work is more important than anything else	MMP7	The job I do here allows me to enjoy my work
MMS8	I would only do a job if I found it enjoyable	MMP8	I find the work I do here enjoyable

An examination of the content of MMP items in table 6 4 1 highlights the nature of their relationship to the concrete experience of the individual in their work environment Rather than addressing the conceptual significance of the type of motivation to the respondent, as done with MMS items, the MMP items relate to the actual experience of the respondents

Table 6 4 2 Items for Instrumental motivation subscale of the MMS BETA and MMP BETA

MMS9	People should always be on the lookout for better-paid jobs	MMP9	This salary I receive here is comparable to other jobs of this type
MMS10	If choosing between jobs the most important criterion is 'which one pays the most'?	MMP10	This job pays well for the work I do
MMS11	I would only work harder if I knew my effort would lead to greater financial reward	MMP11	This job rewards people fairly for the work that they do
MMS12	The best aspects of any job are the financial rewards and associated financial benefits	MMP12	I am satisfied with the financial rewards of this position
MMS13	I only work for the financial reward that it provides me	MMP13	This job provides me with adequate financial reward
MMS14	I would readily leave any job if I were offered an alternative that pays more	MMP14	I am satisfied with my salary and am not currently looking for a better paid job
MMS15	The day I look forward to most in my job is 'pay-day'	MMP15	The salary I receive is a fair reflection of the work I do
MMS16	I really only work for the money	MMP16	The salary I receive in this job is sufficient to meet my needs

Again in table 6 4 2 we see the difference between the degrees of importance that a respondent might place on the scale items relating to the source of motivation of the MMS BETA, and how they might respond to MMP BETA items that address the actual reality of their employment situation

Table 6 4 3 Items for External Self-concept motivation subscale of the MMS BETA and MMP BETA

MMS17	It is important to me that my colleagues should approve of my work behaviour	MMP17	I feel my colleagues approve of my work behaviour
MMS18	The recognition of ones colleagues is the most important reward for a job well done	MMP18	My colleagues recognise when I have done a good job
MMS19	I work harder on a project if public recognition is attached to it	MMP19	This job allows me to be recognised for my contribution to a project
MMS20	People should work hard for the respect and admiration of their peers	MMP20	I believe I have the respect and admiration of my peers
MMS21	I often make decisions based on what others will think	MMP21	I believe my work colleagues think highly of me
MMS22	I work harder when I know others are evaluating my work	MMP22	The hard work I do here is recognised by my work colleagues
MMS23	I give my best effort when I know that it will be seen by the most influential people in an organisation	MMP23	I know my best efforts are recognised by my work colleagues
MMS24	When I have done a good job it is important to me that my contribution is recognised by others	MMP24	I feel I am recognised for contributions I make to this organisation

In table 6 4 3 we see how the personal nature of the motivational source of External Self-concept is linked with the actual experience or provision of this motivation

Table 6 4 4 Items for Internal Self-concept motivation subscale of the MMS BETA and MMP BETA

MMS25	It is important that I work in a job that allows me to use my skills and talents	MMP25	This job allows me to use my skills and talents
MMS26	When choosing between jobs the most important criterion is 'which will provide me with a greater sense of personal achievement'?	MMP26	This job gives me a great sense of personal achievement
MMS27	I consider myself a self-motivated person	MMP27	This job allows me the autonomy to work towards personal achievements
MMS28	It is important that I work in a job that allows me to realise my potential	MMP28	This job allows me the freedom to realise my potential
MMS29	Decisions I make reflect the high standards that I set for myself	MMP29	This organisation allows me to maintain my own high standards at work
MMS30	I get great personal satisfaction from doing a job well	MMP30	The work I do here gives me a sense of personal satisfaction
MMS31	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour	MMP31	This job allows me to make decisions based on my own standards and values
MMS32	I like to do work that challenges me and gives me a sense of personal achievement	MMP32	I find this job challenging and personally satisfying

Again table 6 4 4 highlights the parallel nature of the scales of the MMS BETA and MMP BETA, linking the scientist's responses to motivational sources with their experience of how that motivational source is provided for by their work environment

Table 6 4 5 Items for Goal Internalization motivation subscale of the MMS BETA and MMP BETA

MMS33	I would find it very difficult to work for a company if I didn't agree with its missions and goals	MM P33	I agree with the goals and missions of this organisation
MMS34	I have to believe in a cause before I will work hard at achieving its ends	MM P34	I believe in the goals of this organisation
MMS35	Unless I believe in a cause, I will not work hard for it	MM P35	I believe in what this organisation is trying to achieve
MMS36	When choosing an organisation to work for, I look for one that supports my beliefs and values	MM P36	I feel this organisation supports my values and beliefs
MMS37	An organisation's mission needs to be in agreement with my values for me to work hard	MM P37	The values of this organisation are in line with my personal values
MMS38	I would work harder on a project if I believed in its mission and goals	MM P38	I believe in the mission and goals of this organisation and work hard to help realise them
MMS39	It is important to me that the goals of the organisation I work for are congruent with my personal goals	MM P39	The goals of this organisation are reflected in my personal goals
MMS40	I am unconcerned with personal recognition once the goals of the group I work with are achieved	MM P40	This job allows me to work towards the goals of this organisation

As evident from the MMP BETA items presented in the previous tables, the MMP BETA relates to specific circumstances of the work environment It is primarily a measure a respondent's experience of their external work conditions, as opposed to the MMS BETA, which measures respondent's internal motivational sources

Following the development of scale items for the MMP BETA, two measurement instruments existed Each instrument contained eight statements relating to each of the five subscales of motivation identified m Leonard et al's (1999) meta-theory of

motivation At this stage a pilot study of both instruments was conducted to determine the scale reliabilities of the scales of the MMS BETA and MMP BETA This was conducted to ensure the scale reliability of each of the measures and also to determine if the total number of items in each scale could be reduced The initial reasoning behind the construction of eight items in each subscale was to allow for the later removal of potentially weak items, while still being able to maintain a reasonable number of items in each of the scale

An examination of the scale items of the MMS BETA and MMP BETA, presented previously, shows an element of repetition and possible redundancy in some of the items It was felt that this might lead to some frustration among respondents Consequently the pilot study of the MMS BETA and MMP BETA was also used to aid in 'trimming' the instruments down to a size that potential respondents would be more likely to complete, while retaining the integrity of the instruments

6 5 Evaluation and refinement of the measure of Measure of Motivational Sources Beta

The list of items, which comprise the MMS BETA, were taken from the MMS BETA subscale items presented in tables 6 3 4, 6 3 8, 6 3 12, 6 3 16, and 6 3 20 As evident from these tables each item was allocated a number from 1 to 40 A random ordering of these items was then conducted using a random number generator The final listing of these items is presented in table 6 5 1

Table 6.5.1 Scale Items for the Measure of Motivational Sources BETA (MMS BETA)

ITEM NO.	SCALE ITEMS
MMS3	I would rate 'enjoyment' very highly among reasons why someone should do a job.
MMS19	I work harder on a project if public recognition is attached to it.
MMS31	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour.
MMS21	I often make decisions based on what others will think.
MMS26	When choosing between jobs the most important criterion is 'which will provide me with a greater sense of personal achievement'?
MMS36	When choosing an organisation to work for, I look for one that supports my beliefs and values.
MMS5	If a job were not enjoyable then I'd rather not do it.
MMS11	I would only work harder if I knew my effort would lead to greater financial reward.
MMS29	Decisions I make reflect the high standards that I set for myself
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS8	I would only do a job if I found it enjoyable.
MMS17	It is important to me that my colleagues should approve of my work behaviour.
MMS33	I would find it very difficult to work for an organisation if I didn't agree with its missions and goals.
MMS22	I work harder when I know others are evaluating my work.
MMS30	I get great personal satisfaction from doing a job well.
MMS12	The best aspects of any job are the financial rewards and associated financial benefits.
MMS18	The recognition of ones colleagues is the most important reward for a job well done.
MMS6	If something is not enjoyable then it is not worth doing.
MMS32	I like to do work that challenges me and gives me a sense of personal achievement.
MMS34	I have to believe in a cause before I will work hard at achieving its ends.
MMS10	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS27	I consider myself a self-motivated person.
MMS23	I give my best effort when I know that it will be seen by the most influential people in an organisation.
MMS7	I think being able to enjoy your work is more important than anything else.
MMS1	It is important that the work I do gives me a sense of enjoyment.
MMS25	It is important that I work in a job that allows me to use my skills and talents.
MMS16	I really only work for the money.
MMS14	I would readily leave any job if I were offered an alternative that pays more.
MMS35	Unless I believe in a cause, I will not work hard for it.
MMS38	I would work harder on a project if I believed in its mission and goals
MMS9	People should always be on the lookout for better-paid jobs.
MMS4	I would rather enjoy life than worry about the consequences of my behaviour.
MMS40	I am unconcerned with personal recognition once the goals of the group I work with are achieved.
MMS13	I only work for the financial reward that it provides me.
MMS24	When I have done a good job it is important to me that my contribution is recognised by others.
MMS37	An organisation's mission needs to be in agreement with my values for me to work hard.
MMS39	It is important to me that the goals of the organisation I work for are congruent with my personal goals.
MMS20	People should work hard for the respect and admiration of their peers.
MMS28	It is important that I work in a job that allows me to realise my potential.
MMS15	The day I look forward to most in my job is 'pay-day'.

These statements were then presented as a measurement instrument A 7 point Likert-type scale was positioned beside each statement The Likert-type scale represented responses from Strongly Disagree, to Disagree, Weakly Disagree, Undecided, Weakly Agree, Agree, and finally Strongly Agree

The MMS BETA (appendix B2) together with a copy of the MMP BETA and a letter of introduction (Appendix B1) was sent via internal mail to 72 academics and researchers in the DCU Business School 60 completed instruments were returned Giving a response rate of 83 33% A reliability analysis of the items in each scale was then conducted Results are presented in the following tables

Table 6 5 2 Reliability analysis of MMS BETA Intrinsic process motivation subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMS1 25	30 7833	52 8167	5249	3849	7584
MMS2 10	31 8667	42 6260	7299	6717	7121
MMS3 1	30 4667	57 0667	3351	1833	7807
MMS4 32	33 8000	53 9254	2776	2234	7912
MMS5 7	31 3333	48 2599	4254	3671	7722
MMS6 18	33 6500	48 8415	5289	4598	7520
MMS7 24	31 6167	48 1387	5091	4023	7550
MMS8 11	32 5667	43 5718	6141	5762	7350

The Cronbach alpha reliability analysis for this scale yielded an alpha of 7826, which suggests that there is an acceptable level of reliability for this scale of the MMS BETA However as mentioned previously, one of the primary purposes of the reliability analysis conducted on the eight original items of the Intrinsic process motivation subscale was to identify the possibility of reducing the number of items to

remove unnecessary repetition and redundancy among items in each subscale Consequently an examination of the items of this subscale of the MMS BETA (table 6 5 3) was undertaken

Table 6 5 3 Original Items for Intrinsic Process Motivation Subscale of the MMS BETA

MMS1	It is important that the work I do gives me a sense of enjoyment
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS3	I would rate 'enjoyment' very highly among reasons why someone should do a job
MMS4	I would rather enjoy life than worry about the consequences of my behaviour
MMS5	If a job were not enjoyable then I'd rather not do it
MMS6	If something is not enjoyable then it is not worth doing
MMS7	I think being able to enjoy your work is more important than anything else
MMS8	I would only do a job if I found it enjoyable

As a result of the pilot study and the desire to design a measure that was both reliable and compact it was decided that two items from each of the five subscales could be removed without significantly reducing the reliability of the scales of the instrument In the case of the Intrinsic process motivation subscale, it was decided that items four and five could be removed While this did not offer any real increase to the statistical reliability of the scale, it did serve to reduce the degree of repetition of statements within the scale This left the remaining six items of the scale with a Cronbach alpha reliability of 7843

Following the removal of these items the remaimng items were relabelled from one to six for inclusion in the final version of the MMS These items represent the final set of items that constitute the modified version of the MMS used in the main data collection phase of the study Consequently the term 'beta' is no longer used in the

title of the instrument The final version of this instrument is simply referred to as the Measure of Motivational Sources (MMS)

Table 6 5 4 Final item set for MMS Intrinsic process motivation subscale

MMS1	It is important that the work I do gives me a sense of enjoyment
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS3	I would rate 'enjoyment' very highly among reasons why someone should do a job
MMS4	If something is not enjoyable then it is not worth doing
MMS5	I think being able to enjoy your work is more important than anything else
MMS6	I would only do a job if I found it enjoyable

The results of the scale reliability analysis for MMS BETA Instrumental motivation subscale are presented in table 6 5 5 These results suggest a reliable scale with good inter-item correlations The Cronbach alpha reliability analysis for this scale yielded an alpha of 8746

Table 6 5 5 Reliability analysis of MMS BETA Instrumental motivation subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMS9 31	18 0500	49 0314	6069	4660	8621
MMS10 21	18 5500	49 4042	5892	4938	8640
MMS11 8	18 6167	47 2912	5750	4392	8686
MMS12 16	18 3000	47 9424	7084	5959	8512
MMS13 34	19 1667	50 6158	6907	6589	8553
MMS14 28	19 0167	48 7963	7183	6517	8510
MMS15 40	19 1833	48 2201	5824	4289	8660
MMS16 27	19 5000	51 2712	6920	6972	8562

However as mentioned previously, one of the primary goals of the reliability analysis was to examine the possibility of reducing the size of the instrument while maintaining its reliability Given the positive reliability of the items in this scale,

which are presented in table 6 5 6 It was decided that two items could be removed without compromising the integrity of the scale

Table 6 5.6 Original items for Instrumental motivation subscale of the MMS BETA

MMS9	People should always be on the lookout for better-paid jobs
MMS10	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS11	I would only work harder if I knew my effort would lead to greater financial reward
MMS12	The best aspects of any job are the financial rewards and associated financial benefits
MMS13	I only work for the financial reward that it provides me
MMS14	I would readily leave any job if I were offered an alternative that pays more
MMS15	The day I look forward to most in my job is 'pay-day'
MMS16	I really only work for the money

As there were no obviously weak items within the scale the decision on which items to delete was made primarily on the basis of the desire to reduce the level of repetition among statements in the scale This rational led to items 11 and 15 of the Instrumental subscale being removed, leaving the final six items below These items were then relabelled from seven to 12 for inclusion in the finalised version of the MMS The remaining six items of the scale yielded a Cronbach alpha reliability of 8580

Table 6 5 7 Final Item Set for MMS Instrumental Motivation Subscale

MMS7	People should always be on the lookout for better-paid jobs
MMS8	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS9	The best aspects of any job are the financial rewards and associated financial benefits
MMS10	I only work for the financial reward that it provides me
MMS11	I would readily leave any job if I were offered an alternative that pays more
MMS12	I really only work for the money

The results of the scale reliability analysis for MMS BETA External Self-concept motivation subscale are presented in table 6 5 8 These results suggest a reliable scale with good inter-item correlations The Cronbach alpha reliability analysis for this scale yielded an alpha of 8041

Table 6 5 8 Reliability analysis of MMS BETA External Self-concept motivation subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMS17 12	30 4833	53 1014	5006	3560	7845
MMS18 17	30 5333	56 6938	3880	3010	8000
MMS19 2	29 8500	52 2653	5273	3975	7805
MMS20 38	30 4333	56 4531	4341	2620	7935
MMS21 4	31 2667	49 3175	6330	4809	7629
MMS22 14	30 2833	51 9353	5247	3884	7810
MMS23 23	31 1000	51 2441	5786	4182	7723
MMS24 35	29 8833	55 2573	5451	3236	7798

Again, given the positive reliability of the items in this scale, which are presented in table 6 5 9 It was decided that two of these items could be removed without compromising the integrity of the scale

Table 6 5 9 Original items for External Self-concept motivation subscale of the MMS BETA

MMS17	It is important to me that my colleagues should approve of my work behaviour
MMS18	The recognition of ones colleagues is the most important reward for a job well done
MMS19	I work harder on a project if public recogmtion is attached to it
MMS20	People should work hard for the respect and admiration of their peers
MMS21	I often make decisions based on what others will think
MMS22	I work harder when I know others are evaluating my work
MMS23	I give my best effort when I know that it will be seen by the most influential people in an organisation
MMS24	When I have done a good job it is important to me that my contribution is recognised by others

Following an examination of the items of the scale, it was decided that Items 18 and 20 of the external self-concept subscale could be removed, leaving the final six items below These items were then relabelled from 13 to 18, and are presented in table 6 5 10 The remaining 6 items of the scale yielded a Cronbach alpha reliability of 7975

Table 6.5 10 Final item set for MMS External Self-concept motivation subscale

MMS13	It is important to me that my colleagues should approve of my work behaviour
MMS14	I work harder on a project if public recognition is attached to it
MMS15	I often make decisions based on what others will think
MMS16	I work harder when I know others are evaluating my work
MMS17	I give my best effort when I know that it will be seen by the most influential people in an organisation
MMS18	When I have done a good job it is important to me that my contribution is recognised by others

The results of the scale reliability analysis for MMS BETA Internal Self-concept motivation subscale are presented in table 6 5 11 These results suggest a moderately reliable scale with some weaknesses The Cronbach alpha reliability analysis for this scale yielded an alpha of 6957, fractionally lower than the recommended alpha score of 7 for research instruments

Table 6.5.11 Reliability analysis of MMS BETA Internal Self-concept motivation subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMS25 26	42 8833	15 3929	4143	3468	6705
MMS26 5	44 1500	12 0280	2679	1851	7481
MMS27 22	43 2000	13 3153	3816	2576	6695
MMS28 39	42 9667	14 5073	5176	4587	6497
MMS29 9	43 3167	12 3218	6245	4822	6067
MMS30 15	42 6500	15 5873	4211	3928	6724
MMS31 3	43 0500	15 0992	2902	2958	6858
MMS32 19	43 0000	13 8644	5842	4589	6333

An analysis of the alpha if item deleted statistics shows that the removal of item 26 would increase the scale reliability to an acceptable level A re-examination of the items presented in table 6 5 12 also led to the removal of item 27

Table 6 5 12 Original items for Internal Self-concept motivation subscale of the MMS BETA

MMS25	It is important that I work in a job that allows me to use my skills and talents
MMS26	When choosing between jobs the most important criterion is 'which will provide me with a greater sense of personal achievement'?
MMS27	I consider myself a self-motivated person
MMS28	It is important that I work in a job that allows me to realise my potential
MMS29	Decisions I make reflect the high standards that I set for myself
MMS30	I get great personal satisfaction from doing a job well
MMS31	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour
MMS32	I like to do work that challenges me and gives me a sense of personal achievement

Following the removal of items 26 and 27 of the MMS BETA external self-concept subscale the remaining six items were then relabelled from 19 to 24

Table 6 5 13 Final item set for MMS Internal Self-concept subscale

MMS19	It is important that I work in a job that allows me to use my skills and talents
MMS20	It is important that I work in a job that allows me to realise my potential
MMS21	Decisions I make reflect the high standards that I set for myself
MMS22	I get great personal satisfaction from doing a job well
MMS23	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour
MMS24	I like to do work that challenges me and gives me a sense of personal achievement

The Cronbach alpha for the remaining six items to be included in the MMS was found to be a more acceptable 7537

The results of the scale reliability analysis for MMS BETA Goal Internalization motivation subscale are presented in table 6 5 14 These results suggest a moderately reliable scale with reasonable inter-item correlations The Cronbach alpha reliability analysis for this scale yielded an alpha of 7369

Table 6 5.14 Reliability analysis of MMS BETA Goal Internalization motivation subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMS33 13	32 9167	33 1963	5534	4401	6882
MMS34 20	33 4667	31 8463	5391	4993	6872
MMS35 29	34 2333	29 2328	6024	6437	6699
MMS36 6	32 8333	38 1073	2141	2960	7461
MMS37 36	33 8167	31 9489	5807	6378	6800
MMS38 30	32 7667	32 8938	5726	4634	6844
MMS39 37	33 3500	34 5364	5086	5973	6986
MMS40 33	34 6000	39 7017	0189	1920	7980

An analysis of the alpha if item deleted statistics shows that the removal of item 40 would significantly increase the scale reliability to a more acceptable level A re-examination of the content of the items presented in table 6 5 15 also led to the

removal of item 34 This item was removed to reduce the level of repetition among item statements in this scale

Table 6 5 15 Original items for Goal Internalization motivation subscale of the MMS BETA

MMS33	I would find it very difficult to work for a company if I didn't agree with its missions and goals
MMS34	I have to believe in a cause before I will work hard at achieving its ends
MMS35	Unless I believe in a cause, I will not work hard for it
MMS36	When choosing an organisation to work for, I look for one that supports my beliefs and values
MMS37	An organisation's mission needs to be in agreement with my values for me to work hard
MMS38	I would work harder on a project if I believed in its mission and goals
MMS39	It is important to me that the goals of the organisation I work for are congruent with my personal goals
MMS40	I am unconcerned with personal recognition once the goals of the group I work with are achieved

Following the removal of items 34 and 40 a Cronbach alpha scale reliability statistics was computed for the remaining six items This yielded a Cronbach alpha of 7768 The 6 items were then relabelled from 25 to 30, to be included in the final version of the MMS These items are presented in table 6 5 16

Table 6 5 16 Final item set for MMS Goals Internalization motivation subscale

MMS25	I would find it very difficult to work for a company if I didn't agree with its missions and goals
MMS26	Unless I believe in a cause, I will not work hard for it
MMS27	When choosing an organisation to work for, I look for one that supports my beliefs and values
MMS28	An organisation's mission needs to be in agreement with my values for me to work hard
MMS29	I would work harder on a project if I believed m its mission and goals
MMS30	It is important to me that the goals of the organisation I work for are congruent with my personal goals

The complete set of finalised items of the MMS is presented in table 6.5.17. These items were randomised, using a random number generator. The statements were then presented as a measurement instrument. A 7 point Likert-type scale was positioned beside each statement. The Likert-type scale represented responses from Strongly Disagree, to Disagree, Weakly Disagree, Undecided, Weakly Agree, Agree, and finally Strongly Agree. The finalised version of the MMS, used in the main data collection phase of the study, is presented in appendix B3.

Table 6.5.17 Final item set for the MMS

MMS1	It is important that the work I do gives me a sense of enjoyment.
MMS2	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS3	I often engage in activities just for the sense of enjoyment I get from them.
MMS4	If something is not enjoyable then it is not worth doing.
MMS5	I think being able to enjoy your work is more important than anything else.
MMS6	I would only do a job if I found it enjoyable.
MMS7	People should always be on the lookout for better-paid jobs.
MMS8	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS9	The best aspects of any job are the financial rewards and associated financial benefits.
MMS10	I only work for the financial reward that it provides me.
MMS11	I would readily leave any job if I were offered an alternative that pays more.
MMS12	I really only work for the money.
MMS13	It is important to me that my colleagues should approve of my work behaviour.
MMS14	I work harder on a project if public recognition is attached to it.
MMS15	I often make decisions based on what others will think.
MMS16	I work harder when I know others are evaluating my work.
MMS17	I give my best effort when I know that it will be seen by the most influential people in an organisation.
MMS18	When I have done a good job it is important to me that my contribution is recognised by others.
MMS19	It is important that I work in a job that allows me to use my skills and talents.
MMS20	It is important that I work in a job that allows me to realise my potential.
MMS21	Decisions I make reflect the high standards that I set for myself.
MMS22	I get great personal satisfaction from doing a job well.
MMS23	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour.
MMS24	I like to do work that challenges me and gives me a sense of personal achievement.
MMS25	I would find it very difficult to work for a company if I didn't agree with its missions and goals.
MMS26	Unless I believe in a cause, I will not work hard for it.
MMS27	When choosing an organisation to work for, I look for one that supports my beliefs and values.
MMS28	An organisation's mission needs to be in agreement with my values for me to work hard.
MMS29	I would work harder on a project if I believed in its mission and goals.
MMS30	It is important to me that the goals of the organisation I work for are congruent with my personal goals.

6 6 Evaluation and refinement of the Measure of Motivational Provisions Beta

Following the revision of the MMS BETA to yield the final version of the MMS used in the main data collection phase of the current study, a similar exercise was conducted on the MMP Beta The lists of items, which comprise the MMP BETA, were taken from the MMP BETA subscale items presented in tables 6 4 1, 6 4 2, 6 4 3, 6 4 4, and 6 4 5 As evident from these tables each item was allocated a number from one to 40 A random ordering of these items was then conducted using a random number generator These statements were then presented as a measurement instrument (see appendix C1) A 7 point Likert-type scale was positioned beside each statement The Likert-type scale represented responses from Strongly Disagree, to Disagree, Weakly Disagree, Undecided, Weakly Agree, Agree, and finally Strongly Agree

This instrument together with a copy of the MMS BETA (discussed previously) and a letter of introduction (see Appendix B1) was sent via internal mail to 72 academics and researchers in the DCU Business School 60 completed instruments were returned Giving a response rate of 83 33% A reliability analysis of the items in each scale was then conducted Results of which are presented in the following tables

As a result of the pilot study and the desire to design a measure that was both reliable and compact it was decided that two items from each of the five subscales could be removed without significantly reducing the reliability of the instruments In addition to this, retaining six items in each of the five subscales allows for easy comparison between total scores of subscales on the MMS and MMP

Table 6 6 1 Original items for Intrinsic process motivational provisions subscale of the MMP BETA

MMP1	The work I do in my current job gives me a sense of enjoyment
MMP2	I do this job because I enjoy the work
MMP3	I get a sense of enjoyment from the activities I engage in, in this job
MMP4	I find the work I do in this organisation enjoyable
MMP5	I enjoy the work I do here
MMP6	The work I do here is enjoyable
MMP7	The job I do here allows me to enjoy my work
MMP8	I find the work I do here enjoyable

The reliability analysis of this subscale of the MMP BETA confirmed the reliability of the items of this subscale The Cronbach alpha coefficient for the subscale was found to be 9352

Table 6.6 2 Reliability analysis of MMP BETA Intrinsic process motivational provisions subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMP1 3	41 9500	19 0653	8123	7141	9237
MMP2 4	42 1000	18 9390	6858	5813	9364
MMP3 36	42 0500	18 9636	7704	6418	9274
MMP4 22	42 0833	20 3828	8246	7345	9246
MMP5 39	42 0000	19 2881	8370	7460	9219
MMP6 10	42 1333	20 2531	8345	7365	9238
MMP7 14	42 1000	19 8881	7604	6384	9275
MMP8 18	42 0500	20 3534	7552	6473	9282

Considering the high reliability scores for all items of the scale it was felt that reducing the number of the items of the scale would not compromise the reliability of the scale Items six and eight of the Intrinsic subscale were removed, to reduce the occurrence of conceptual repetition in the items The final items of the Intrinsic subscale are presented in table 6 6 3 These items were then relabelled from one to six

for inclusion in the final MMP The Cronbach alpha coefficient for the remaining six items was found to be 9145

Table 6 6 3 Final item set for MMP Intrinsic process motivational provisions subscale

MMP1	The work I do in my current job gives me a sense of enjoyment
MMP2	I do this job because I enjoy the work
MMP3	I get a sense of enjoyment from the activities I engage in, in this job
MMP4	I find the work I do m this organisation enjoyable
MMP5	I enjoy the work I do here
MMP6	The job I do here allows me to enjoy my work

The reliability analysis of the Instrumental motivational provision subscale of the MMP BETA confirmed the reliability of the items of this subscale The results of this analysis are presented in table 6 6 5 The Cronbach alpha coefficient for the subscale was found to be 9315 The original items of the MMP BETA for this subscale are presented in table 6 6 4

Table 6 6 4 Original items for Instrumental motivational provisions Subscale of the MMP BETA

MMP9	This salary I receive here is comparable to other jobs of this type
MMP10	This job pays well for the work I do
MMP11	This job rewards people fairly for the work that they do
MMP12	I am satisfied with the financial rewards of this position
MMP13	This job provides me with adequate financial reward
MMP14	I am satisfied with my salary and am not currently looking for a better paid job
MMP15	The salary I receive is a fair reflection of the work I do
MMP16	The salary I receive in this job is sufficient to meet my needs

In order to reduce the degree of repetition and possible redundancy of items in this subscale, the original items of the MMP BETA, presented m table 6 6 4, were re-examined This examination led to the removal of items 11 and 14

Table 6 6 5 Reliability analysis of MMP BETA Instrumental motivational provisions subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMP9 15	32 8167	102 8980	4932	4763	9414
MMP10 7	33 4333	90 6904	8570	7929	9151
MMP11 40	33 5000	103 1695	5327	3420	9379
MMP12 23	33 3500	90 2314	9255	8871	9103
MMP13 13	32 9500	92 2517	8378	8101	9168
MMP14 26	32 8833	93 7658	7515	6289	9234
MMP15 31	33 4167	88 6879	9218	8799	9099
MMP16 21	33 1833	92 6268	7892	7100	9205

The remaining items were then relabelled from seven to 12 for inclusion in the final version of the MMP, and are presented in table 6 6 6 A reliability analysis of the remaining six items yielded a Cronbach alpha coefficient of 9330

Table 6 6 6 Final item set for MMP Instrumental motivational provisions subscale

MMP7	This salary I receive here is comparable to other jobs of this type
MMP8	This job pays well for the work I do
MMP9	I am satisfied with the financial rewards of this position
MMP10	This job provides me with adequate financial reward
MMP11	The salary I receive is a fair reflection of the work I do
MMP12	The salary I receive in this job is sufficient to meet my needs

A reliability analysis of the MMP BETA items of the External Self-concept presented in table 6 6 7 yielded positive results The figures presented in table 6 6 8 highlight the strong reliability of the subscale The Cronbach alpha coefficient for the External Self-concept subscale of the MMP BETA was found to be 8975

Table 6 6 7 Original items for External Self-concept motivational provisions subscale of the MMP BETA

MMP17	I feel my colleagues approve of my work behaviour
MMP18	My colleagues recognise when I have done a good job
MMP19	This job allows me to be recognised for my contribution to a project
MMP20	I believe I have the respect and admiration of my peers
MMP21	I believe my work colleagues think highly of me
MMP22	The hard work I do here is recognised by my work colleagues
MMP23	I know my best efforts are recognised by my work colleagues
MMP24	I feel I am recognised for contributions I make to this organisation

Considering the strength of this scale, it was felt that items 21 and 23 of the external self-concept subscale could be removed, to reduce the level of conceptual repetition among statements without compromising the integrity of the subscale

Table 6 6 8 Reliability analysis of MMP BETA External Self-concept motivational provisions subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMP17 38	34 2333	41 8090	5992	5930	8918
MMP18 30	34 7000	34 9593	8675	8146	8648
MMP19 17	34 7333	37 4531	7550	7010	8772
MMP20 9	34 2333	44 6904	4792	5262	9007
MMP21 32	34 3167	44 0845	4927	5409	8997
MMP22 16	34 6500	36 6720	8252	7751	8701
MMP23 5	34 9500	37 1669	6672	6475	8877
MMP24 6	35 1500	36 5025	7643	6816	8763

The six remaining items, presented in table 6 6 9, were than relabelled from 13 to 18 These items were retained for inclusion the final version of the MMP The Cronbach alpha reliability for the six remaining items of this subscale was found to be 8884

Table 6 6 9 Final Item Set for MMP External Self-concept motivational provisions subscale

MMP13	I feel my colleagues approve of my work behaviour
MMP14	My colleagues recognise when I have done a good job
MMP15	This job allows me to be recognised for my contribution to a project
MMP16	I believe I have the respect and admiration of my peers
MMP17	The hard work I do here is recognised by my work colleagues
MMP18	I feel I am recognised for contributions I make to this organisation

The items of the Internal Self-concept subscale of the MMP BETA, presented in table 6 6 10, were also subjected to a reliability analysis The results of this analysis are presented in table 6 6 11

Table 6 6 10 Original items for Internal Self-concept motivational provisions subscale of the MMP Beta

MMP25	This job allows me to use my skills and talents
MMP26	This job gives me a great sense of personal achievement
MMP27	This job allows me the autonomy to work towards personal achievements
MMP28	This job allows me the freedom to realise my potential
MMP29	This organisation allows me to maintain my own high standards at work
MMP30	The work I do here gives me a sense of personal satisfaction
MMP31	This job allows me to make decisions based on my own standards and values
MMP32	I find this job challenging and personally satisfying

The Cronbach alpha for this subscale was found to be 8680 This confirmed the statistical reliability of the subscale and also showed that items of the subscale could be removed without compromising the reliability of the subscale

Following an examination of the items presented in table 6 6 10, items 27 and 31 of the external self-concept subscale were removed As mentioned previously this was done to reduce the degree of repetition and redundancy of items within the MMP BETA

Table 6 6 11 Reliability analysis of MMP BETA Internal Self-concept motivational provisions subscale

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMP25 28	41 2833	22 4099	7267	6667	8432
MMP26 35	41 3500	20 6720	8247	7413	8290
MMP27 25	41 2500	22 5975	6130	7007	8529
MMP28 20	41 5833	20 1116	6969	6107	8436
MMP29 19	41 6167	23 3251	3454	4705	8886
MMP30 12	41 1167	21 5963	8170	7881	8334
MMP31 34	41 4833	24 4234	3918	2609	8741
MMP32 2	41 1833	21 4743	6956	7236	8434

The remaining six items of the subscale were then relabelled from 19 to 24 for their inclusion in the final version of the MMP (see table 6 6 12) The Cronbach alpha coefficient of the six remaining items of this subscale of the MMP was found to be 8621

Table 6 6 12 Final Item Set for MMP Internal Self-concept motivational provisions subscale

MMP19	This job allows me to use my skills and talents
MMP20	This job gives me a great sense of personal achievement
MMP21	This job allows me the freedom to realise my potential
MMP22	This orgamsation allows me to maintain my own high standards at work
MMP23	The work I do here gives me a sense of personal satisfaction
MMP24	I find this job challenging and personally satisfying

The eight original items of the MMP BETA scale for goal internalization motivation (see table 6.6.13) were also subjected to a reliability analysis.

Table 6.6.13 Original items for Goal Internalization motivational provision subscale of the MMP Beta.

MMP33	I agree with the goals and missions of this organisation.
MMP34	I believe in the goals of this organisation
MMP35	I believe in what this organisation is trying to achieve.
MMP36	I feel this organisation supports my values and beliefs.
MMP37	The values of this organisation are in line with my personal values.
MMP38	I believe in the mission and goals of this organisation and work hard to help realise them.
MMP39	The goals of this organisation are reflected in my personal goals.
MMP40	This job allows me to work towards the goals of this organisation.

The results of this analysis, presented in table 6.6.14, highlight the high degree of inter-item correlation between the items of this scale. The Cronbach alpha for the eight items of the scale was found to be .9480. In order to reduce the degree of repetition contained within the item statements, it was decided that two items could be removed without compromising the integrity of the scale. This decision led to the removal of items 34 and 40 of the goal internalization subscale.

Table 6.6.14 Reliability analysis of MMP BETA Goal Internalization motivational provision subscale.

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item total Correlation	Squared Multiple Correlation	Alpha if Item Deleted
MMP33.11	35.4333	44.9616	.7413	.5940	.9453
MMP34.29	35.4833	42.2879	.9123	.8769	.9343
MMP35.24	35.5333	40.9989	.8849	.8573	.9358
MMP36.27	35.8333	42.5480	.8547	.7845	.9379
MMP37.33	35.6333	42.2362	.9042	.8506	.9347
MMP38.37	35.7000	42.7220	.9107	.8707	.9347
MMP39.8	36.0333	42.2701	.7315	.6346	.9478
MMP40.1	35.2500	47.3771	.5651	.4118	.9554

The remaining six items, presented in table 6 6 15 were then relabelled from 25 to 30 for inclusion in the final version of the MMP An analysis of the Cronbach alpha for the final six items yielded a highly respectable score of 9431

Table 6 6 15 Final Item Set for MMP Goal Internalization Motivational Provisions Subscale

MMP25	I agree with the goals and missions of this organisation
MMP26	I believe in what this organisation is trying to achieve
MMP27	I feel this organisation supports my values and beliefs
MMP28	The values of this organisation are in line with my personal values
MMP29	I believe in the mission and goals of this organisation and work hard to help realise them
MMP30	The goals of this organisation are reflected in my personal goals

A complete list of items included in the final version of the MMP is presented in table 6 6 16 This list represents the final items presented to participants during the main data collection phase of the current study The order of the items was randomised and a 7 point Likert-type scale was positioned beside each statement The Likert-type scale represented responses from Strongly Disagree, to Disagree, Weakly Disagree, Undecided, Weakly Agree, Agree, and finally Strongly Agree This final version of the MMP is presented in Appendix C2

Table 6 6 16 Final Item Set for the MMP

MMP1	The work I do in my current job gives me a sense of enjoyment
MMP2	I do this job because I enjoy the work
MMP3	I get a sense of enjoyment from the activities I engage in, in this job
MMP4	I find the work I do in this organisation enjoyable
MMP5	I enjoy the work I do here
MMP6	The job I do here allows me to enjoy my work
MMP7	This salary I receive here is comparable to other jobs of this type
MMP8	This job pays well for the work I do
MMP9	I am satisfied with the financial rewards of this position
MMP10	This job provides me with adequate financial reward
MMP11	The salary I receive is a fair reflection of the work I do
MMP12	The salary I receive in this job is sufficient to meet my needs
MMP13	I feel my colleagues approve of my work behaviour
MMP14	My colleagues recognise when I have done a good job
MMP15	This job allows me to be recognised for my contribution to a project
MMP16	I believe I have the respect and admiration of my peers
MMP17	The hard work I do here is recognised by my work colleagues
MMP18	I feel I am recognised for contributions I make to this organisation
MMP19	This job allows me to use my skills and talents
MMP20	This job gives me a great sense of personal achievement
MMP21	This job allows me the freedom to realise my potential
MMP22	This organisation allows me to maintain my own high standards at work
MMP23	The work I do here gives me a sense of personal satisfaction
MMP24	I find this job challenging and personally satisfying
MMP25	I agree with the goals and missions of this organisation
MMP26	I believe in what this organisation is trying to achieve
MMP27	I feel this organisation supports my values and beliefs
MMP28	The values of this organisation are in line with my personal values
MMP29	I believe in the mission and goals of this organisation and work hard to help realise them
MMP30	The goals of this organisation are reflected in my personal goals

6 7 The identification and development of the measures of scientific effectiveness

The primary output or dependent variable in the current study is that of scientific effectiveness Consequently a measure of scientific effectiveness was required for use with the sample of scientists participating in the current study The measurement and evaluation of scientific effectiveness is a complex and sensitive area How we define effectiveness, evaluate quality over quantity, and quantify the potential value of scientific outputs all add to the complexity of this issue Essentially the measurement of scientific productivity is a measurement of knowledge generation However

knowledge generation cannot be measured directly, rather it is assessed indirectly by examining research outputs such as books, journal articles, reviews, patents, prototypes, etc The complexity of such a task is illustrated by the detailed measurement of scientific productivity employed by the Unesco study (Unesco, 1979), which initially identified 56 potential measures of what they termed research productivity

Within the academic domain common research performance measures include publication counts, citation indexing, the more complex bibliometric mapping (Van Raan, 1996) and multi-objective measurement (Nagpaul & Santanu, 2003) In addition to these approaches many individual countries employ government-initiated performance based measures to inform funding decisions New Zealand's Performance Based Research Fund (PBRF) and the UK's Research Assessment Exercise (RAE) are examples of such measures

Prior to a final decision being made on the selection of a measure of scientific effectiveness for use in the current study, an analysis of the requirements of the measure was conducted The needs of the current study required a measure of research performance that (a) was non-contentious to the participants taking part in the study, (b) easy to administer and score, (c) would not be resource intensive, (d) would allow for comparison of performance levels across scientific disciplines and (e) would have verifiable reliability

An evaluation of existing performance measures such as the bibliometric mapping, publication counts, and citation indexing found them to be unsuitable for use, as none of these measures met the requirements of the study listed above Consequently an

alternative measure of research performance evaluation was required This need for an alternative measure of research effectiveness led to the development of the Self-evaluation of Research Profile and Performance (SERPP)

6 7 1 SERPP measurement construction

The first stage of measurement construction involved the interviewing of research scientists to determine their perception of how research productivity and performance could be assessed, meeting the needs of the study outlined above

A series of unstructured interviews were scheduled with several research active scientists (N = 7) in an Irish University The scientists themselves were from various disciplinary backgrounds (2 physicists, 2 chemists, 1 mathematician, and 2 biotechnologists) The interviews were held in an informal setting, with the general theme of the interview being 'the measurement of research effectiveness' In some cases interviewees were contacted on more than one occasion to discuss advances and variations to the measurement instrument developed

An analysis of notes taken during the interviews yielded two consistent findings Firstly it was generally reported by the scientists that no existing measure of research performance was viewed as universally satisfactory or acceptable Secondly, given the continuing evaluation of a scientists research outputs that takes place throughout their career, at organisational, national and international levels, individual scientists believe they have a reasonably accurate perception of their 'place' within the scientific community This perception of their 'place' reflects their research

performance/productivity, the recognition they have received for their work from peers, and their success in attaining funding for their research

This first finding confirmed the need for the development of a new measure of research performance While the second finding suggested that this new measure could be a self-evaluation measure

Several possible structures and formats were presented to the participating scientists The results of feedback and comments from the interviewees led to the instrument presented in appendix D, known as the 'Self-evaluation of Research Profile and Performance' (SERPP) The instrument is based on the premise that in the process of a scientific career a research scientist constructs a research profile, which is a function of the quality and quantity of their work, and how it is received in the scientific community During the process of evaluation that occur within the scientific community the scientists gain a clear understanding of how their profile reflects on them as a researcher and their 'place' within the larger scientific community

The basic structure of the SERPP contains three sections, each with a Likert type 5-point scale The three sections relate to the respondents institutional profile, national profile, and international profile The institutional profile relates to the respondents view of where their 'place' is within the research hierarchy of their institution The national profile relates to the respondents sense of 'place' at a national level, while the international profile relates to the scientists view of their 'place' within their research domain at an international level

As the scientific community is essentially an international community, it is this international level that was of primary significance, as this more clearly allows for the comparison of scientists across disciplines For example, we might imagine a situation whereby an average researcher working in a very narrow or novel field of research may quite reasonably assess themselves very highly on an institutional and national level of performance, simply due to the scarcity of other researchers in their field at the institutional and national levels However such a researcher would rate his/herself much lower on the international level, when comparing their research with that of international peers (given an accurate self-evaluation)

Consequently it is the international level that is of primary interest as a measure of research performance here The decision to include the other levels of performance (institutional and national) was made following discussion with the scientists participating in the development of the instrument It was felt that the inclusion of the first two levels would help focus the respondent's attention and required a more reflective analysis of their position as researchers, which would in turn lead to more accurate self-evaluations of their research profile at the international level As mentioned previously a final version of the Self-evaluation of Research Profile and Performance (SERPP) used in the main data collection phase of the current study is presented in appendix D

6 7.2 The RAE as a measure of scientific effectiveness

In addition to the individual measure of scientific effectiveness constructed for used in the current study, a measure of research effectiveness at the level of the organisation

was also required Several measures of research effectiveness are discussed in chapter five, the most comprehensive of which is that employed in the Unesco (1979) study While this instrument is extremely detailed and inclusive of a large number of performance criteria it is also extremely cumbersome, and requires evaluations from relevant experts in specific research fields, as well as detailed information relating to scientific outputs from participating organisations These requirements preclude its use in the current study

As an alternative to the Unesco (1979) method of measurement of scientific effectiveness, the United Kingdoms, Higher Education & Research Opportunities (HERO), Research Assessment Exercise (RAE) was examined

The RAE is a UK government initiated research performance measure that is designed to enable higher education authorities to distribute public research funds selectively to research departments in tertiary institutions on the bases of their research quality The assessment, which takes place every four to five years, provides research quality ratings for academic departments across all academic disciplines, and on the bases of these ratings distributes approximately UK£1 billion a year (HERO, 2002a)

The quality ratings themselves, which range from 1 to 5*, are based on detailed submissions from the participating departments Relevant experts evaluate submissions through a peer review process These experts are usually academic professionals but in some instances, members of the industrial and commercial community are involved These panels usually comprise from nine to eighteen members In all there were 68 units of assessment in the 2001 RAE, with each unit

comprising a broad academic discipline such as Electrical and Electronic Engineering, Environmental Sciences, Pharmacology, Biological Sciences, or Psychology

University research departments, or units, identify the assessment unit under which their research falls and make a submission that encompasses several categories to the RAE The categories under which information is provided include staff information, research outputs, textual description, and related data Within the category of staff information research units are expected to present information that includes summaries of all academic staff, details of research active staff and details of research support staff and research assistants Under the research outputs category up to four items of research output for each researcher is permitted Textual descriptions include information about the research environment, its structure and policies, strategies for research development, and qualitative information on research performance and esteem Finally under the category of related data, research units include such information as the amount and sources of research funding, numbers of research students, numbers and sources of research studentships, numbers of research degrees awarded, and indicators of peer esteem (HERO, 2002a)

The assessment panels that make the evaluative judgments on submissions across the various units of assessment each draw up a statement describing their working methods, highlighting the aspects of the submission that they view as most important This information is published in advance of submissions to assist in fair and consistent evaluations across the various units of assessment (HERO, 2002a) Each submission is evaluated by the panel of experts and rated accordingly

While the RAE is certainly not a perfect or flawless evaluation procedure, it does provide relatively thorough, and detailed evaluation of the quality of research across a large number of research departments in UK universities, based on the information contained within each submission This information, as described earlier, is similar in nature to that employed in the evaluation of research performance in the Unesco (1979) study in includes a variety of dimensions in the analysis of performance As such the RAE offers the most readily available and comprehensive evaluation of research effectiveness suitable for use in the current study It also offers the additional benefit of allowing for the stratified sampling of scientists from research departments of varying levels of research effectiveness

6 8 The measurement of the organisational environment

The final measurement instrument required for the operationalisation of all variables contained within the model of research effectiveness developed in the current study was that of the measurement of characteristics of the organisational environment The first step in the search for a measure of the organisational environment that would be suitable for use in the current study required an examination of characteristics of the organisational environment that have been previously identified as important in influencing scientific effectiveness A summary of these characteristics, which was identified in the course of the literature review, is presented in table 5 1 and is repeated again here for the reader's convenience

The information presented in table 5 1 highlights the variety of organisational characteristics that have been identified by different researchers as important in

influencing scientific effectiveness A review of this material in chapter five also highlights the varied and complex way in which many of these characteristics were identified and measured and the degree of overlap, where similar organisational characteristics have been identified by different researchers

Table 5 1 (Repeated) Summary of organisational characteristics believed to influence scientific effectiveness

ARGYRIS (1968)	BAUMGARTEL (1956)	GLUECK & THORP (1971)	THAMHAIN & WILEMON (1987)	BLAND & RUFFIN (1992)	HURLEY (1997)	MOULY & SANKARAN (1998)	CHAWLA & SINGH (1998)
Organisational structure	Leadership	preparation and planning	Leadership	Clear goals	Good selection processes	Lenience in recruitment processes professional mediocrity	Leadership
technology	Freedom in decision making	organisation/ coordination	Job content	Research emphasis	High morale	Poor self-image	Work environment
Administrative controls		control/ conflict	Personal goals	Distinctive organisational culture	Positive group membership and supervision	Lack of team identity and role clarity	Policies
Human controls		organisation climate	Work environment	Adequate recruitment and selection process	Autonomy of work teams	Lack of institutional autonomy in project selection	Communication
Leadership styles		evaluation		Assertive participative governance	Supportive organisational culture	Excessive bureaucracy apathetic attitudes	Resources
Interpersonal relations and communication				Decentralised organisational structure	Effective communication	Strained interpersonal relationships	Planning
Group effectiveness				Size age and diversity of the group	Effective leadership styles	Apathetic supervision authoritarianism within the institutes hierarchy	
Inter-group relations				Appropriate reward structure			
Norms of the living system				Frequent and open communication			
				Positive group climate			
				Adequate resources			
				Effective leadership			

One of the key difficulties in examining conceptual similarities across research projects is the difficulty in assigning equivalence to concepts, due to variation in the instruments used to measure them For example the concept of leadership is identified repeatedly in table 5 1 However due to the large degree of variation in leadership theories and conceptual definitions of leadership, understanding the role and importance of this concept to scientific effectiveness is not a simple task

As stated in chapter five, several possibilities presented themselves with regard to the identification of appropriate instruments to measure the organisational characteristics identified in table 5 1 Due to the varying methodologies employed, and the number of concepts involved, the ready identification of an existing instrument that has been used in the study of the characteristics of the research organisation was not possible

Due to the limitations of existing instruments and the methodological variations that exist among historical research projects on the topic of scientific effectiveness, it was decided that the construction of a measure of organisational characteristics based on a conglomeration of existing instruments would not be appropriate as the items being measured may not be conceptually sound It was also feared that any such conglomeration would lead to an instrument that was excessively large and might affect participants' willingness to complete the instrument Consequently a search for a suitable existing instrument was undertaken The conditions of this search were that the instrument must reasonably measure as many organisational characteristics that are conceptually similar to those identified in the literature review, as possible In addition its validity and reliability must be well documented

A review of instruments designed to measure aspect of the organisational environment identified the Organizational Culture Survey (OCS) (Glaser et al , 1987) as the most appropriate instrument for use in the current study The OCS was designed to operationalise organisational culture within the confines of a standardized questionnaire While this is not a universally acceptable approach to the study of organisational culture (Rubin, Palmgreen, & Sypher, 1994), the instrument itself measures six dimensions of the organisational environment These six factors represent sufficient conceptual similarity to ensure their suitability for use in the current study The six factors contained within the OCS include Teamwork, Morale, Information Flow, Involvement, Supervision, and Meetings

An examination of the items of the OCS highlights the relationship between the concepts measured by the instrument and many of the concepts contained within table 5 1 A more detailed examination of the concepts of the OCS and a detailed examination of the concepts presented in table 5 1 is presented here as a rational for the use of the OCS, and to highlight the conceptual similarity between the factors of the OCS and many of the factors identified in the literature review Essentially the similarities and overlap between factors with comparable conceptual meaning that is presented here is similar to the review, analysis and integration of characteristics of the effective research organisation carried out by Bland and Ruffin (1992)

The first factor of the OCS examined in relation to the concepts contained in table 5 1 is that of Teamwork The OCS items used in the measurement of the concept of teamwork (see appendix G) relate to the degree to which members of a team are able to communicate effectively, resolve disagreement, and constructively confront

problems An examination of the concepts contained in table 5 1 shows that the concept of teamwork as measured by the items of the OCS can be reasonably related to several of the concept contained within this table For example good interpersonal relations and communication are identified by Argyris (1968) as organisational factors that influence the effectiveness of research organisations These concepts relate directly to the concept of teamwork as measured by the OCS There is also conceptual overlap between the OCS concept of teamwork, and Argyris' concept of intergroup relations Similarly the positive group climate referred to by Bland and Ruffin (1992) is also directly related to the OCS concept of teamwork Hurley's (1997) identification of positive group membership also shows considerable overlap with the OCS concept of teamwork, as does the concept of strained interpersonal relationships identified by Mouly and Sankaran (1998) The concept of the work environment as identified in the Unesco (1979) study, and by Thamhain and Wilemon (1987) similarly shows considerable conceptual overlap with the OCS concept of teamwork Teamwork, as operationalised by the OCS is also related to the concept of control/conflict, as identified by Glueck and Thorp (1971)

The next OCS factor examined is that of Morale This factor relates to the degree of harmony that exists between employees and management, and the degree to which employees are motivated to perform Clearly this OCS concept incorporates the concept of high morale identified by Hurley (1997) It is also strongly related to the concept of poor self-image as identified by Mouly and Sankaran (1998)

The next OCS factor examined is that of Information Flow The items that comprise this factor relate to the degree to which the relevant information is available to

organisation members to allow them to do their job adequately, and the degree to which they are kept abreast of larger organisational issues This concept is related to several of the factors listed in table 5 1 For example the concept of organisational structure as identified by Argyris (1968) relates to the classical perspectives of organisational theory and the nature and degree to which information flows through an organisation Similarly Bland and Ruffin's (1992) concept of decentralized organisational structure also exhibits considerable conceptual overlap with the OCS factor of information flow, and is even more clearly related to their concept of frequent and open communication We can also see the conceptual similarity between what Glueck and Thorp refer to as coordination, and the OCS factor of information flow Obvious overlap exists between the concept of communication as identified by Hurley (1997), and Chawla and Singh (1998), and the OCS factor of information flow Additionally an examination of Mouly and Sankaran's (1998) concept of team identity and role clarity shows that this aspect of the work environment stems primarily from poor communication and inadequate information flow within the organisation

The next OCS factor examined here is that of Involvement This factor relates to the degree to which organisational members are involved in decision-making and the degree to which they have influence over the organisation and the work that they do This factor is quite clearly related to several of the factors contained within table 5 1 The most obvious links can be seen between Baumgartels (1956) factor of freedom in decision making, and Hurley's (1997) factor of autonomy of work teams The OCS concept of Involvement is also related to Argyris' (1968) concept of administrative controls, as tight administrative control limits organisational members ability to

influence their work environment and how it is organised This concept is also related to Thamhain and Wilemon's (1987) concept of personal goals Where organisational members have no involvement in the organisation and selection of their work, it is less likely that they will be meeting their personal goals within the work environment

The OCS factor of Supervision has obvious conceptual overlap with several of the factors identified in table 5 1 Supervision as measured by the OCS relates to the ability and effectiveness of supervisors in the organisational context This factor is directly related to concepts of leadership identified by Argyris (1968), Baumgartel (1956), Thamhain and Wilemon (1987), Bland and Ruffin (1992), Hurley (1997), and Chawla and Singh (1998), it is also related to Glueck and Thorp's (1971) concept of evaluation, which relates to the degree to which supervisors provide effective evaluation and feedback to subordinates Supervision as measure by the OCS is also related to Bland and Ruffin' (1992) concept of clear goals, and assertive participative governance Mouly and Sankaran's (1998) concept of apathetic supervision and authoritarianism within the institute's hierarchy is also conceptually related to the OCS concept of Supervision

The final OCS factor labeled Meetings is related to the degree to which meetings are productive, participatory and lead to positive outcomes This factor is conceptually related to several of the concepts identified in table 5 1 Specifically we can see the conceptual similarity between meetings as measured by the OCS and Argyris' (1968) concept of group effectiveness There is also considerable overlap between this concept and Glueck and Thorp's (1971) concept of preparation and planning, Mouly and Sankaran's (1998) concept of excessive bureaucracy and apathetic attitudes and

Chawla and Singh's (1998) concept of planning

In addition to the conceptual similarity and relationships identified between individual factors of the OCS and factors presented in table 5 1 we can also see conceptual similarity between the OCS as a whole and more general organisational concepts such as Glueck and Thorp's (1971) factor, organisation climate, and Bland and Ruffin's (1992), and Hurley's (1997) concepts of organisational culture The original purpose of the OCS was to act as a measure of organisational culture It is reasonable then to view the instrument as conceptually related to alternative concepts of organisational culture and climate

As we can see there is considerable conceptual overlap between the factors contained within table 5 1 and the factors measured in the OCS Indeed a detailed examination of the factors presented in table 5 1 show that a large number of them are conceptually synonymous with each other, and exhibit considerable conceptual synonymy with the factors of the OCS

This analysis of the OCS and the factors presented in table 5 1 suggested that the OCS would be a suitable instrument for use in the current study The conceptual similarity between the concepts measured by the OCS and those concepts presented in table 5 1 provides for the measurement of a sufficient range of organisational characteristics, using a relatively compact measurement instrument The individual items that make up the OCS are presented in table 6 8 1

Table 6 8 1 The 36 items for the OCS (Glaser et al , 1987)

OCS1	People I work with are direct and honest with each other
OCS2	People I work with accept criticism without becoming defensive
OCS3	People I work with resolve disagreements co-operatively
OCS4	People I work with function as a team
OCS5	People I work with are co-operative and considerate
OCS6	People I work with constructively confront problems
OCS7	People I work with are good listeners
OCS8	People I work with are concerned about each other
OCS9	Labour and management have a productive working relationship
OCS10	This organisation motivates me to put out my best efforts
OCS11	This organisation respects its workers
OCS12	This organisation treats people in a consistent and fair manner
OCS13	Working here feels like being part of a family
OCS14	There is an atmosphere of trust in this organisation
OCS15	This organisation motivates people to be efficient and productive
OCS16	I get enough information to understand the big picture here
OCS17	When changes are made the reasons why are made clear
OCS18	I know what's happening in work sections outside my own
OCS19	I get the information I need to do my job well
OCS20	I have a say in decisions that affect my work
OCS21	I am asked to make suggestions about how to do my job better
OCS22	This organisation values the ideas of workers at every level
OCS23	My opinions count in this organisation
OCS24	Job requirements are made clear by my supervisor
OCS25	When I do a good job my supervisor tells me
OCS26	My supervisor takes criticism well
OCS27	My supervisor delegates responsibility
OCS28	My supervisor is approachable
OCS29	My supervisor gives me criticism in a positive manner
OCS30	My supervisor is a good listener
OCS31	My supervisor tells me how I'm doing
OCS32	Decisions made at meetings get put into action
OCS33	Everyone takes part in discussions at meetings
OCS34	Our discussions in meetmgs stay on track
OCS35	Time in meetmgs is time well spent
OCS36	Meetings tap the creative potential of the people present

Despite the degree of conceptual overlap between the OCS and the factors identified in table 5 1 it was felt that the concept of recruitment and selection referred to by Bland and Ruffin (1992), Hurley (1997), and Mouly and Sankaran (1998) was not sufficiently addressed by the items of the OCS Consequently a number of additional items were added to the OCS to measure this concept These items were incorporated from a study by Conway (2003) The items developed by Conway were designed to measure an organisations selection practices

The items presented in table 6 8 2 are those incorporated from Conway (2003) and were added to the existing 36 items of the OCS to complete the measure of organizational characteristics used in the main data collection phase of the current study This measurement instrument is referred to as the OCS Revised

Table 6 8 2 Additional five items relating to organisational selection from Conway (2003)

37	The company makes every effort to attract and hire the most highly skilled people in the industry
38	Job seekers are more attracted to work for this Organisation than similar ones in the industry
39	The selection procedures used here (e g psychological tests, interviews) are effective in selecting the "right" people
40	The people who join this company "fit in" well with those already employed here
41	The company takes sufficient steps to ensure that new employees are aware of "how things are done around here"

A total of 41 items are contained within the OCS Revised These items were randomized and each item was presented with a corresponding, 1 to 5 Likert type scale (see appendix E) This instrument was then employed in the main data collection phase of the current study as the measure of organisational characteristics

To further illustrate the relationship between the factors measured by the OCS Revised and the factors presented in table 5 1, table 5 1a lists the original factors presented in table 5 1 but also lists the OCS factor that they are conceptually related to This highlights the breath of organisational factors that are conceptually bound within the OCS Revised It should be noted that the author does not claim that the OCS Revised accurately measures each of the concepts contained within table 5 1 as

intended by the original authors of the studies included in this table. Rather the author attests to the conceptual similarity of many of the concepts contained within table 5.1, and the strength of the conceptual relationships between many of these factors and the factors measured by the OCS Revised.

Table 5.1a Summary of organisational characteristics believed to influence scientific effectiveness related to OCS Revised factors

ARGYRIS (1968)	BAUMGARTEL (1956)	GLUECK & THORP (1971)	THAMHAIN & WILEMON (1987)	BLAND & RUFFIN (1992)	HURLEY (1997)	MOULY & SANKARAN (1998)	CHAWLA & SINGH (1998)
Organisational structure *Infoflow*	Leadership *Supervision*	preparation and planning *Meetings*	Leadership *supervision*	Clear goals *Supervision*	Good selection processes *Selection*	Lenience in recruitment processes, professional mediocrity *Selection*	Leadership *Supervision*
technology	Freedom in decision making *Involvement*	organisation/ coordination *Info flow*	Job content	Research emphasis	High morale *Morale*	Poor self-image *Morale*	Work environment *Teamwork*
Administrative controls *Involvement*		control/ conflict *Teamwork*	Personal goals *Involvement*	Distinctive organisational culture *All*	Positive group membership and supervision *Teamwork*	Lack of team identity and role clarity *Info flow*	Policies *Selection*
Human controls *Selection*		organisation climate *All*	Work environment *Teamwork*	Adequate recruitment and selection process *Selection*	Autonomy of work teams *Involvement*	Lack of institutional autonomy in project selection Involvement	Communica-tion *Info flow*
Leadership styles *Supervision*		Evaluation *Supervision*		Assertive participative governance *Supervision*	Supportive organisational culture *All*	Excessive bureaucracy, apathetic attitudes Meetings	Resources
Interpersonal relations and communication *Teamwork*				Decentralised organisational structure *Involvement*	Effective communica-tion *Info flow*	Strained interpersonal relationships Teamwork	Planning *Meetings*
Group effectiveness *Meetings*				Size age and diversity of the group	Effective leadership styles *Supervision*	Apathetic supervision, authoritarian-ism within the institutes hierarchy *Supervision*	
Inter-group relations *Teamwork*				Appropriate reward structure			
Norms of the living system				Frequent and open communica-tion *Info flow*			
				Positive group climate *Teamwork*			
				Adequate resources			
				Effective leadership *Supervision*			

As we can see from table 5 1a, of the 52 concepts contained with the table, 44 can be seen to be conceptually synonymous with factors of the OCS Revised, and of the remaining eight, three refer to physical or financial aspects of the work environment that are not addressed in this research study Indeed it is likely that an informed expert in the area of organisational theory could well identify even more conceptual overlap between OCS Revised factors and the factors presented m table 5 1, but for the purposes of this research, sufficient conceptual overlap has been established to validate the selection of the OCS Revised as an appropriate measure of organisational characteristics for use in the current study

6 9 Conclusion

The preceding chapter presented a description of the processes of instrument construction and selection In all, four key measurement instruments were required, the Measure of Motivational Sources, the Measure of Motivational Provisions, the Self-evaluation of Research Profile and Performance, and the Organizational Culture Survey Revised What follows in chapter seven is a description of the methods employed in using these measurement instruments to collect the necessary data to examine the research goals and hypotheses of the current study

CHAPTER SEVEN
METHODOLOGY

7 1 Introduction

Thus far this study has reviewed literature on the organisational factors related to scientific effectiveness and on motivational theory, with the aim of providing and testing an integrated model of scientists motivation and scientific effectiveness within the research organisation

Evidence from previous research has hypothesised that to maximise the probability of scientific effectiveness requires a combination of suitable characteristics of the scientist and suitable characteristics of the organisational research environment (Hurley, 1997) In addition to this research has also highlighted the importance of motivation and the influence the environment can have on the scientist's ability to think creatively (Amabile, 1988) These separate avenues of research have led to the development of the organisational/motivational model of scientific research effectiveness to be examined in this study, the explicit research objectives of which are identified in chapter five as a number of key research goals to be met and hypotheses to be tested

Following is a description of the methodology employed m the current study, including the sample population who participated m the study, the tools used to measure the many variables deemed to be important in the study, and the manner in which the study was conducted

7 2 Sample selection

This study draws on data from 330 scientists working in 27 research departments in 20 UK Universities A list of potential participants was constructed using the Research Assessment Exercise (RAE) scores for UK university departments In order to adequately test the model developed during the course of the current study participants of varying levels of scientific effectiveness were required to take part The RAE scores for UK university departments, described in chapter six, facilitated the identification of these individuals The logic of participant selection was based on the concept that there is a relationship between the scientific effectiveness of the individuals that make up a university research department and the RAE score of that department This is a logical and reasonable assumption to make as the RAE scores awarded to UK university departments is strongly determined by the submission of the research profiles of the individual scientists that make up that department, to the RAE exercise

The first stage of sample selection was the identification of a population of scientists from which to draw a participant sample In the current study the population of scientists was limited to research active scientists working in UK university departments who had taken part in the UK's RAE, and were working in research departments in the fields of biological and/or chemical research A list of such departments and their RAE scores was collected from data available from the website of the Higher Education and Research Opportunities in the United Kingdom (HERO, 2002b)

Departments were then separated by RAE grade from 5* to 3b Though the actual grades of the RAE run from 5* to 1, the number of possible participants departments that were awarded a grade of 2 or 1 were so few that it was believed an insufficient number of participants could be collected from these groups Consequently these departments were excluded

The lists of departments in each grade of the RAE from 5* through to 5, 4, 3a, and 3b were then randomised Contact was then made with the heads of department in each list starting at the top of each list The heads of departments were contacted via email and phone and the nature of the study was explained to them, while access to their staff was requested This step was repeated down the lists of departments until sufficient sample size was procured 897 research scientists were requested to participate in the study, 330 responded, giving a response rate of 36 8% Participation in the study at both the departmental and individual levels was voluntary, and confidentiality was assured

7.3 The participants

As stated previously an initial sample of 897 scientists working in biological/ and or chemical science departments were issued with a questionnaire booklet containing the measurement instruments utilised in the current study A total of 330 scientists responded, yielding a response rate of 36 8%

7.3 1 Gender

Of the total of 330 respondents 272 (82 4%) were male, 58 (17 6%) were female

7 3 2 Age

Data presented in figure 7 1 identifies the age distribution of participants in the current study

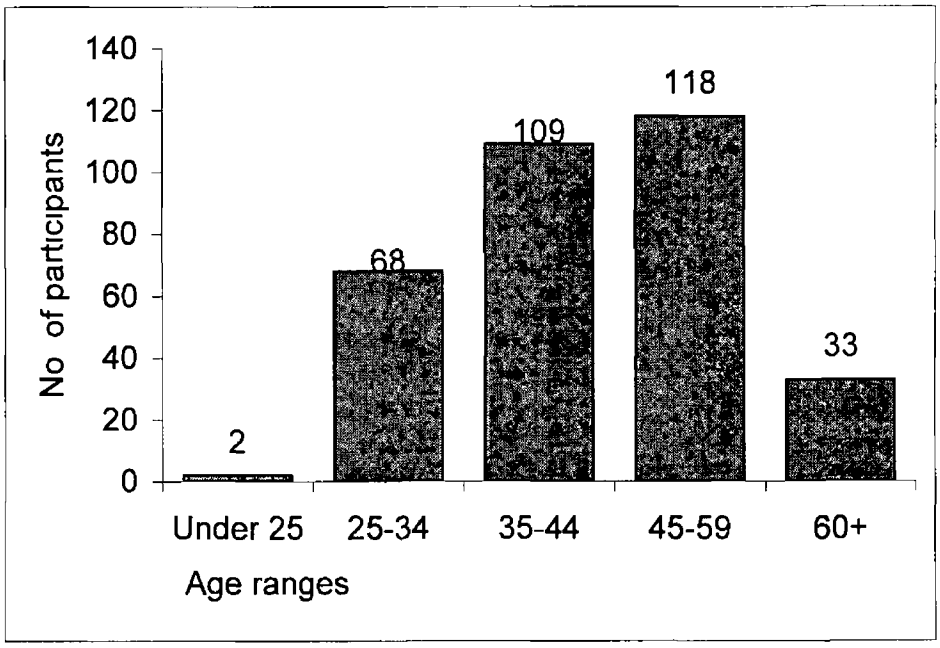
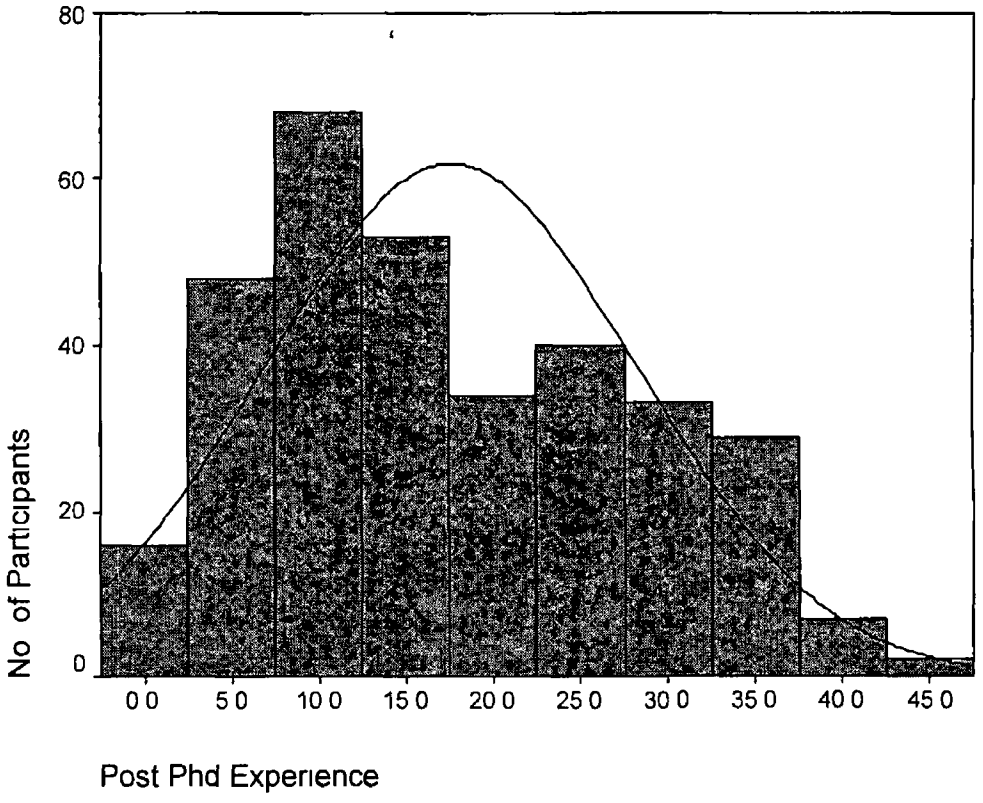


Figure 7 1 Bar chart of numbers of participants in specified age ranges

7 3 3 Participants research experience

Displayed in figure 7 2 is a histogram outlining the distribution of years of post-PhD research experience among participants in the current study



7 2 Histogram of post PhD research experience of participants

The Mean post-PhD experience of the participants was 17 58yrs The Median was 16yrs while the Mode was 12yrs The standard deviation was reported as 10 63

7 4 Materials and apparatus used for data collection and analysis

The materials used for data collection in the current study, included a booklet of paper and pencil measurement instruments This booklet contained (a) a letter of introduction, (b) a copy of the Measure of Motivational Sources, MMS, (c) a copy of the Measure of Motivational Provisions, MMP, (d) a copy of the Self-evaluation of Research Profile and Performance, SERPP and (e) a copy of the scientists biographical questionnaire (appendix H)

Results from the analyses of the reliability and validity of these instruments is presented in chapter eight

Data analyses was conducted using SPSS, version 11 0 0 (SPSS, 2001), and Microsoft Excel, version 9 6 6926 (Microsoft, 1999)

7 5 Procedure

The procedure employed for the main data collection phase of the current study was as follows Data was collected from individual scientists whose departments agreed to participate in the current study in one of two ways In the first instance, where possible the researcher visited the department at an agreed date and time During this visit the booklet of questionnaires was distributed in person to potential participants Participants were requested to complete the booklet and return it to the researcher by the end of the day or mail the completed booklet to the researcher at a time suitable to the participant

In the second instance, where an onsite visit to the department was not favoured by the participating department or was not feasible for the researcher, a copy of the booklet of questionnaires was mailed to the work addresses of all research active staff in the participating department Included with the questionnaire booklet was a self-addressed envelope to assist participants in returning the completed questionnaire to the researcher

Data from the completed questionnaires was then inputted into an SPSS file for analysis The data from a haphazard selection of 30 completed questionnaires were then rechecked to ensure accuracy in data entry

7 6 Conclusion

The preceding sections describe the participants and the methods employed in the main data collection phase of the current study Following from this, and prior to the presentation of results relating to the goals and hypotheses of the current study, an examination of the validity and reliability of instruments from the data collected in the main data collection phase is presented in chapter eight

CHAPTER EIGHT
ANALYSES OF MEASURES AND INSTRUMENTS

8.1 Introduction

Many of the theoretical concepts included in this study required the construction of new and as such untested measures Chapter eight examines the validity and reliability of the measures used in the current study This was done to ensure that the analyses of data collected using these measures, and presented later in chapter eight, are valid and meaningful In the cases of the Measure of Motivational Sources (MMS) a factor analysis incorporating all responses to this instrument was carried out Where necessary items were removed until several clear factors could be identified Once these factors had been identified, the Cronbach alpha coefficient of reliability for the scale items of which a factor was comprised was computed Similarly a factor analysis was conducted on the items of the MMP Again the factors identified with this procedure were examined using the Cronbach alpha coefficient of reliability

In the case of the OCS Revised a factor analysis was not deemed necessary as this instrument has been widely used and validated (Rubin et al , 1994, Zamanou & Glaser, 1989) However to determine the reliability of the scales of the OCS for the current sample of research scientists a Cronbach alpha reliability coefficient was computed for each scale of the OCS Revised Additionally participant scores on the Self-evaluation of Research Profile and Performance (SERPP) were examined in relation to a known measure of research performance, namely the REA scores for departments m which the scientists work

8 2 Construct validity of the Measure of Motivational Sources (MMS)

As described in chapter six the MMS was constructed to measure an individual's level of motivation across a number of motivational constructs Specifically the sources of motivation defined in Leonard et al's (1999) meta-theory of motivation The construction of the instrument involved the subtle alteration and incorporation of scale items from an existing measure, the MSI (Barbuto & Scholl, 1998), the construction of new items based on data collected from the 'ENWOP Group' (Appendix A1) and an examination and incorporation of items from existing motivation measures

During the construction of the MMS and MMP every care was taken to ensure that the items chosen for inclusion were conceptually sound A pilot study to test the reliability of the scales was conducted and following some revision, described in chapter five, the instrument was deemed suitable for use in the current study While it would have been useful to conduct a factor analysis of the scale items prior to the main data collection phase this was not possible A pilot sample of at least 150 participants would be required to run a reasonably accurate factor analysis for the MMS and MMP (Comrey & Lee, 1992, Gorsuch, 1983) The large number of participants required to provide a sufficiently large data set for a useful factor analysis at the pilot stage was beyond the temporal and financial limits of the study In addition to this every participation of a research scientist at the pilot stage was a drain on the overall sample available for the main study Consequently to ensure that sufficient numbers of participants existed for the main study, the use of these participants during the pilot stage was limited The factor analyses following were conducted on raw scores for all participant responses on the MMS (n=330)

To ensure that objectivity was maintained throughout the factor analysis *a priori* evaluation criteria were established Firstly, components would only be retained whose eigenvalues were greater than 1 (Kaiser, 1960) Secondly for any item to be accepted as belonging to a factor, and to be able to inform us as to the conceptual meaning of that factor, it would have to present a rotated component matrix coefficient in excess of 0 4 in one and only one factor (Stevens, 2002) A factor loading in excess of ± 30 is generally accepted as a moderate to high loading for factor analytic evaluations (Charlton, 2002) However in this instance, given the novelty of the instruments under investigation and the desire to adhere to high standards of instrument construction it was decided to seek a factor loading equal to or in excess of ± 40 as used by Christensen and Piper-Terry (2004) and Swinkels, Kuyk, van Dyck and Spinhoven (2004) Finally for a factor to be recognised, it must contain at least two scale items, i e single item factors would be discarded This final condition was introduced to ensure that reasonable attempts could be made to understand the 'conceptual meaning' of a factor

To test the factorial relationship between the individual items which make up the MMS a varimax rotated factor analysis was conducted (Kaiser, 1960) This rotation method allows for greater ease of interpretation of the final factors The results of this initial factor analysis are displayed in table 8 2 1 overleaf

Table 8 2 1 Initial rotated component matrix for all items of the MMS

	Component							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
MMS10 13	**78**	17	- 00	01	- 06	- 00	- 14	35
MMS9 5	**77**	02	- 01	15	01	13	09	- 06
MMS8 19	**76**	17	- 09	00	03	- 03	06	- 10
MMS12 14	**71**	13	- 10	- 10	- 12	- 02	- 21	34
MMS11 25	**71**	04	09	- 07	01	- 17	18	- 21
MMS7 29	**67**	20	08	- 01	- 06	- 10	- 08	- 14
MMS17 17	20	**79**	08	05	04	- 01	04	04
MMS14 27	15	**77**	13	04	11	07	-00	- 08
MMS16 11	13	**74**	07	16	- 15	01	06	01
MMS15 28	10	**64**	- 12	03	- 04	- 12	24	07
MMS6 21	- 02	08	**74**	05	06	13	04	- 07
MMS2 16	- 10	11	**70**	11	12	- 11	02	17
MMS4 2	32	- 09	**67**	06	- 07	- 04	- 09	- 07
MMS5 26	- 15	10	**57**	09	- 07	07	05	36
MMS1 24	- 02	- 02	**55**	08	09	32	22	20
MMS26 30	07	30	**41**	27	09	11	- 38	- 28
MMS30 6	06	- 06	-02	**82**	07	- 01	22	- 01
MMS25 7	- 04	02	07	**82**	10	02	02	10
MMS28 10	08	20	24	**69**	01	11	- 06	- 12
MMS27 12	- 08	18	23	**68**	13	07	- 08	03
MMS29.3	09	13	- 04	28	25	15	- 13	25
MMS22 22	05	03	10	- 02	**76**	- 04	22	03
MMS21 18	- 08	01	06	04	**73**	21	05	- 14
MMS23 23	- 01	- 06	01	17	**72**	11	- 20	06
MMS24 8	- 14	- 01	- 04	19	**50**	33	10	08
MMS20 20	- 01	06	09	02	22	**80**	10	- 01
MMS19 1	- 08	- 04	08	10	13	**75**	- 04	03
MMS18 4	23	25	12	05	08	24	**63**	01
MMS13 15	- 02	44	07	10	09	- 07	**56**	- 11
MMS3 9	- 09	- 06	38	01	03	02	03	**68**

Extraction Method Principal Component Analysis Rotation Method Varimax with Kaiser Normalization (Rotation converged in 15 iterations)

As we can see from table 8 2 1, eight factors emerged from the data set However the eighth factor contains only one item (MMS3 9) As this item stands in isolation, and contravenes the *a priori* evaluation criteria for this factor analysis it was deleted from the MMS data set In addition we can also see item MMS29 3 standing in isolation This item does not relate sufficiently well (> 4) to any factor to warrant its continued inclusion in the analysis Consequently this item was also removed and the remaining MMS items were reanalysed, using the varimax rotated factor analysis The results of

this reanalysis are presented in table 8 2 2

Table 8 2 2 Rotated component matrix for MMS items (Items MMS 29 3 & MMS3 9 removed)

	Components						
	1	**2**	**3**	**4**	**5**	**6**	**7**
MMS10 13	**79**	18	04	00	- 10	07	- 22
MMS9 5	**77**	02	- 02	16	02	12	11
MMS8 19	**76**	16	- 11	01	04	- 05	09
MMS12 14	**73**	14	- 04	- 11	- 16	06	- 28
MMS11 25	**70**	03	04	- 06	04	- 23	25
MMS7 29	**67**	19	05	- 03	- 03	- 14	14
MMS17 17	20	**79**	08	05	05	- 01	05
MMS14 27	15	**76**	15	05	12	04	04
MMS16 11	14	**74**	09	16	- 15	02	05
MMS15 28	10	**65**	- 11	03	- 05	- 09	22
MMS6 21	- 01	05	**73**	06	09	09	09
MMS2 16	- 10	11	**72**	10	11	- 07	- 04
MMS4 2	32	- 13	**64**	07	- 05	- 11	02
MMS5 26	- 14	09	**64**	07	- 11	13	- 01
MMS1 24	- 01	- 02	**57**	07	08	35	19
MMS26 30	07	27	39	29	13	03	- 24
MMS30 6	05	- 05	-02	**82**	07	08	21
MMS25 7	- 03	02	02	**81**	08	06	- 01
MMS28 10	08	19	23	**70**	02	07	00
MMS27 12	- 07	19	22	**69**	14	08	- 09
MMS22 22	04	04	10	- 02	**75**	- 01	19
MMS21 18	- 08	00	04	05	**74**	18	08
MMS23 23	- 06	- 05	01	18	**71**	13	- 24
MMS24 8	- 13	- 04	- 03	20	**49**	35	08
MMS20 20	- 01	05	09	03	23	**78**	10
MMS19 1	- 07	- 09	09	10	14	**74**	- 04
MMS18 4	21	23	12	04	07	24	**66**
MMS13 15	- 04	43	05	10	10	- 08	**58**

Extraction Method Principal Component Analysis Rotation Method Varimax with Kaiser Normalization (Rotation converged in 6 iterations)

The factors analysis of the remaining MMS items shows seven factors An examination of the component matrix highlights some inconsistencies in the data Firstly item MMS26 30 no longer correlates sufficiently well with any of the remaining factors to warrant its inclusion Secondly an examination of items MMS18 4 and MMS13 15 show them forming a separate factor (Factor 7) Further examination of these items also show item MMS13 15 to be moderately related to

factor two It appears that item MMS13 15 is sufficiently related to factors two to warrant inclusion in this factor However its relation to item MMS18 4 appears to be pulling it out of factor two According to the *a priori* evaluation criteria for the factor analysis an item should only be included in a factor if it loads in excess of 4 in one and only one factor Clearly this is not the case for item MMS13 15 Two possible methods of dealing with this incongruity were identified Firstly item MMS13 15 could be removed from the data set This would leave item MMS18 4 in isolation and to its consequent removal Alternatively, considering the recognised correlation between item MMS13 15 and factor two, item MMS 18 4 could be removed, allowing for the reintegration of item MMS 13 15 into factor two This latter method was chosen and as can be seen from table 8 2 3, upon reanalysis, item MMS13 15 does correlate well with factor two

Table 8 2 3 Rotated component matrix for MMS items (Item MMS3 9, MMS18 4, MMS29 3 & MMS26 30 removed)

	Component					
	1	**2**	**3**	**4**	**5**	**6**
MMS10 13	**80**	09	03	04	- 16	10
MMS9 5	**76**	03	16	- 02	05	08
MMS8 19	**76**	19	- 00	- 12	06	- 06
MMS12 14	**74**	03	- 09	- 05	- 24	10
MMS11 25	**69**	11	- 08	04	11	- 26
MMS7 29	**66**	21	- 09	04	- 08	- 15
MMS17 17	22	**78**	06	09	- 00	04
MMS16 11	15	**73**	16	09	- 18	06
MMS14 27	17	**73**	05	14	06	09
MMS15 28	11	**.69**	02	- 11	- 05	- 08
MMS13 15	- 05	**58**	07	06	21	- 14
MMS25 7	- 04	01	**.82**	02	07	05
MMS30 6	04	02	**81**	- 02	13	- 04
MMS27 12	- 06	15	**.70**	22	10	10
MMS28 10	09	19	**69**	22	02	08
MMS6 21	- 01	07	06	**74**	10	06
MMS2 16	- 09	10	12	**73**	09	- 07
MMS5 26	- 13	09	08	**65**	- 12	13
MMS4 2	32	- 12	07	**63**	- 03	- 13
MMS1 24	- 01	04	06	**59**	14	30
MMS22 22	04	10	- 02	11	**.76**	- 03
MMS21 18	- 08	03	05	04	**.74**	19
MMS23 23	00	- 11	20	02	**63**	18
MMS24 8	- 13	01	19	- 04	**51**	34
MMS20 20	- 00	06	02	10	27	**.76**
MMS19 1	- 06	- 10	10	11	16	**74**

Extraction Method Principal Component Analysis Rotation Method Varimax with Kaiser Normalization (Rotation converged in 6 iterations)

Following the identification of four items for removal from the data set, the factor analysis of the remaining items indicates that there are six consistent factors contained within participants responses on the MMS These factors account for 57 56% of the variance for this data set The Cronbach scale reliabilities of these factors are presented in table 8 2 4

Table 8 2 4 Cronbach scale reliabilities for MMS factors

Factor	Cronbach alpha
Factor 1	8370
Factor 2	7717
Factor 3	7816
Factor 4	6977
Factor 5	6726
Factor 6	6009

Having identified the items relating to each factor, further examination of the content of each factor was conducted to identify the conceptual meaning of each factor

8 3 MMS factor content and scale reliability

In order to clearly identify the conceptual meaning of each factor, an examination of the content of each of the items contained in each factor was carried out The following section examines the content of each of the items remaining in the factor analysis and explores how the conceptual relationships between items inform us of the conceptual meaning of each factor

Factor 1 Instrumental Motivation

The content of the items relating to factor one are presented in table 8 3 1 A cursory examination of these items suggests that the underlying concept relates to the importance a respondent would place on external rewards The continuing references to 'financial rewards', 'pay' and 'money' are consistent with the concept of Instrumental motivation as defined by (Leonard et al , 1999), and as intended by the

initial construction of the MMS

Table 8 3 1 MMS scale items for Factor 1 Instrumental motivation

MMS10/13	I only work for the financial reward that it provides me
MMS9/5	The best aspects of any job are the financial rewards and associated financial benefits
MMS8/19	If choosing between jobs the most important criterion is 'which one pays the most'?
MMS12/14	I really only work for the money
MMS11/25	I would readily leave any job if I were offered an alternative that pays more
MMS7/29	People should always be on the lookout for better-paid jobs

Hitherto the results reported on respondent's scores on the Instrumental motivation subscale refer to their responses to the six items listed in table 8 3 1 In order to determine the internal consistency of the scale a Cronbach reliability analysis was conducted The alpha coefficient for these six items was found to be 0 8370

Factor 2 External Self-Concept Motivation

Table 8 3 2 shows the scale items identified under factor two An examination of these items shows them to be originally designed to measure the concept of External Self-Concept Motivation, with one omission The original MMS construction of this scale included item MMS18/4 However, as described earlier and seen in table 8 2 3 this item was removed from the analysis The remaining five items are clearly related to the motivational meta-theory's concept of External Self-concept motivation (Leonard et al , 1999) Repeated reference to the importance of external evaluation and approval are integrally related to this concept, as intended by the initial

construction of this MMS scale

Table 8.3 2 MMS scale items for Factor 2 External Self-concept motivation

MMS17/17	I give my best effort when I know that it will be seen by the most influential people in an organisation
MMS16/11	I work harder when I know others are evaluating my work
MMS14/27	I work harder on a project if public recognition is attached to it
MMS15/28	I often make decisions based on what others will think
MMS13/15	It is important to me that my colleagues should approve of my work behaviour

The internal consistency of these five scale items was also examined This examination yielded a Cronbach alpha coefficient of 0 7717 Hitherto any reference to participant's scores on External Self-Concept Motivation will relate specifically to their responses to the five statements listed in table 8 3 2

Factor 3 Goal Internalization Motivation

The items presented in table 8 3 3 identify this factor as being conceptually related to Goal Internalization motivation (Leonard et al , 1999) as intended by the original construction of items for the MMS Continuing reference to the importance of congruence between organisational and individual goals are consistent with the conceptual meaning of this motivational construct The original construction of this scale included items MMS29 3 and MMS26 30 However their poor relation to any factor identified in the factor analysis led to their deletion All future references to participant's scores for Goal Internalization motivation are based solely on their responses to the four statements presented in table 8 3 3 An examination of the internal consistency of these items yielded a Cronbach alpha of 0 7816

Table 8 3.3 MMS scale items for Factor 3 Goal Internalization motivation

MMS25/7	I would find it very difficult to work for a company if I didn't agree with its missions and goals
MMS30/6	It is important to me that the goals of the organisation I work for are congruent with my personal goals
MMS27/12	When choosing an organisation to work for, I look for one that supports my beliefs and values
MMS28/10	An organisation's mission needs to be m agreement with my values for me to work hard

Factor 4 Intrinsic Motivation

The scale items relating to factor four are presented in table 8 3 4 A cursory examination of these items shows them to relate to the concept of Intrinsic process motivation as defined by Leonard et al (1999) The continuing references to 'enjoyment' are conceptually linked to the idea of intrinsic motivation, engaging in a task for the enjoyment of the task itself Only one item from the original construction of the MMS was removed during the factor analysis item MMS3 9 This item did not meet the *a priori* conditions of the factor analysis and was consequently removed

Table 8.3 4 MMS scale items for Factor 4 Intrinsic process motivation

MMS6/21	I would only do a job if I found it enjoyable
MMS2/16	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'
MMS5/26	I think being able to enjoy your work is more important than anything else
MMS4/2	If something is not enjoyable then it is not worth doing
MMS1/24	It is important that the work I do gives me a sense of enjoyment

An examination of the internal consistency of this scale revealed a Cronbach alpha of 0 6977

Factors 5 Internal Self-concept Motivation

An examination of the items displayed in table 8 3 5 show them to be conceptually related to the concept of Internal Self-concept motivation as defined by Leonard et al (1999) The 'personal' nature and relation of the work to the individual, and their ability to identify their work with their own standards, reflects the core concepts of this motivational construct The importance of personal values and standards, rather than the expectation of others are central to the idea of the internal self-concept

Table 8.3 5 MMS scale items for Factor 5 Internal Self-concept motivation

MMS22/22	I get great personal satisfaction from doing a job well
MMS21/18	Decisions I make reflect the high standards that I set for myself
MMS23/23	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour
MMS24/8	I like to do work that challenges me and gives me a sense of personal achievement

An examination of the internal consistency of this scale revealed a moderate Cronbach alpha of 0 6726

Factor 6 Achievement Need Motivation

The identification of six factors from the factors analysis conducted on the MMS data set does not correspond with the original aim of MMS construction, which was to construct an instrument to measure the five factors identified in the meta-theory of motivation (Leonard et al , 1999) However this factor meets the *a priori* conditions for factor retention and clearly warrants further examination Table 8 3 6 shows the two items that make up this factor During the original construction of the MMS these items were included due to their supposed conceptual relation to Leonard et al's (1999) Internal Self-concept motivation However the factor analysis clearly shows

these two items to be forming an individual factor in isolation of Internal Self-concept motivation In order for factor six to be of any practical use in informing us of the nature of scientists motivations it is important that some conceptual meaning be derived from the two items of the factor To do this a re-examination of the concepts of the meta-theory of motivation was conducted

Within their explanation of Internal Self-concept motivation Leonard et al (1999) describe a duality within the construct

'The individual tends to use fixed rather than ordinal standards of self-measurement as he/she attempts to first reinforce perceptions of competency, and later achieve higher levels of competency This need for achieving higher levels of competency is similar to what McClelland (McClelland, 1961) refers to as a high need for achievement " Leonard et al (1999) p 984

The first aspect of this concept is the reinforcement of perceptions of competency in the individual, by repeatedly meeting their own standards of behaviour and performance, while the second aspect, the later achievement of higher levels of competency, sees the individual strive for greater levels of achievement based on their personal standards

This duality can reasonably account for the identification of two factors relating to the general concept of Internal self-concept motivation The first, factor five, relating more strictly to Leonard et al's (1999) concept of Internal Self-concept motivation, the second, factor 6, relating more clearly to McClelland's need for achievement

While the items presented in table 8 3 5 relate more clearly to the idea of motivation through the attainment and reinforcement of internal standards and notions of the ideal self, those presented in table 8 3 6 might be more readily associated with the latter aspect of Leonard et al's (Leonard et al , 1999) internal-self concept construct, that of the achievement need It is the importance of future facilitation, the work environment 'allowing' for higher levels of achievement, facilitating the potential for growth of the ideal self, that separates factors five and six

Table 8 3.6 MMS scale items for Factor 6 Achievement Need motivation

MMS20/20	It is important that I work in a job that allows me to realise my potential
MMS19/1	It is important that I work m a job that allows me to use my skills and talents

Hitherto factor six is referred to as Achievement Need motivation Consequently any future reference to participant's levels of Achievement Need motivation will relate directly to their scores on the two items of factor six, items MMS20 20 and MMS19 1

An examination of the internal consistency of this scale revealed a Cronbach alpha of 6009 While this is only a moderate coefficient for these items, it was deemed adequate for discussion at least, considering the factor only consists of two items

8 4 Construct validity of the Measure of Motivational Provisions (MMP)

The Measure of Motivational Provisions (MMP) was designed as a complimentary measure to assist in examining the relationship between a scientists sources of work motivation and the degree to which their place of work facilitates those sources of motivation Initial MMP construction attempted to measure the degree to which the

workplace met the motivational sources described in the meta-theory of motivation (Leonard et al , 1999) To test the validity of this construction a factor analysis of the raw scores for all participant responses to the MMP from the main data collection phase of the study was conducted (N=330)

To ensure that objectivity was maintained throughout the factor analysis the same *a priori* evaluation criteria that were established for the analysis of the MMS were set for the MMP analysis Firstly, components would only be retained whose eigenvalues were greater than 1 (Kaiser, 1960) Secondly for any item to be accepted as belonging to a factor, and to be able to inform us as to the conceptual meaning of that factor, it would have to present a rotated component matrix coefficient in excess of 0 4 in one and only one factor (Stevens, 2002) Finally for a factor to be recognised it must contain at least two scale items, i e single item factors would be discarded This final condition was introduced to ensure that reasonable attempts could be made to understand the 'conceptual meaning' of a factor

Once again a varimax rotated factor analysis was conducted (Kaiser, 1960) to test the factorial relationship between the individual items which make up the MMP The results of this initial factor analysis are displayed in table 8 4 1

Table 8 4 1 Initial rotated component matrix for MMP

	Component				
	1	**2**	**3**	**4**	**5**
MMP23 26	**87**	16	02	16	07
MMP1 19	**87**	**14**	05	17	05
MMP4 28	**85**	14	03	15	05
MMP3 15	**85**	14	- 06	14	05
MMP24 20	**85**	22	03	20	08
MMP5 5	**83**	21	07	17	05
MMP20 23	**80**	21	04	17	00
MMP6 11	**79**	20	12	18	02
MMP2 21	**77**	05	00	09	- 00
MMP21 2	**62**	38	18	09	09
MMP25 14	14	**91**	00	10	- 03
MMP28 3	20	**89**	07	10	14
MMP29 22	15	**87**	00	11	- 05
MMP26 29	20	**87**	00	**14**	06
MMP30 7	21	**86**	02	15	- 04
MMP27 12	25	**82**	07	25	00
MMP22 4	**46**	**55**	09	19	20
MMP9 24	06	02	**93**	04	00
MMP10 17	07	- 02	**89**	10	08
MMP8 16	03	06	**88**	09	- 04
MMP11 1	00	04	**85**	12	- 05
MMP12 18	09	01	**70**	09	- 03
MMP7 9	03	11	**48**	05	39
MMP17 27	29	22	17	**78**	05
MMP13 10	11	03	00	**77**	09
MMP14 8	23	23	15	**76**	07
MMP16 30	23	16	11	**74**	- 04
MMP18.25	28	**43**	29	**54**	05
MMP15 13	32	**43**	10	**48**	- 18
MMP19 6	20	00	- 03	08	**89**

Extraction Method Principal Component Analysis Rotation Method Varimax with Kaiser Normalization (Rotation converged in 5 iterations)

The initial factor analysis shows five factors emerging from the raw data However, further examination of the factor analysis reveals that several items do not meet the evaluation criteria set down for the factor analysis The first of these irregularities can be seen in item MMP22 4 The second evaluation criteria for the factor analysis states that for any item to be accepted as belonging to a factor, and to be able to inform us as to the conceptual meaning of that factor, it would have to present a rotated component matrix coefficient in excess of 0 4 in one and only one factor As we can see from

table 8 4 1 item MMP22 4 presents a coefficient in excess of 0 4 in two factors And as such cannot offer sufficiently clear conceptual meaning to either of the factors Consequently it was removed Similarly items MMP18 25 and MMP15 13 show correlation coefficients in excess of 0 4 in more than one factor and were subsequently removed

Finally factor five can be identified as having only one item contained within it This contravenes the third, and final, evaluation criteria for the MMP factor analysis, that no single item factors are to be retained Item MMP19 6 was consequently removed Following the removal of the four items mentioned above, the remaining items were re-analysed The results of this analysis are presented in table 8 4 2

Table 8 4 2 shows four factors emerging from the factor analysis for the MMP These four factors account for 73 14% of the variance for this data set Having identified the items relating to each factor, the next step was to identify the conceptual meaning of each factor

Table 8 4.2 Rotated component matrix for MMP (Less items MMP22 4, MMP18 25, MMP15 13 and MMP19 6)

	Component			
	1	**2**	**3**	**4**
MMP23 26	**88**	15	03	14
MMP1 19	**87**	14	06	17
MMP4 28	**86**	13	04	14
MMP24 20	**86**	21	04	18
MMP3 15	**85**	14	05	14
MMP5 5	**.83**	20	08	15
MMP20 23	**81**	20	05	16
MMP6 11	**79**	19	13	16
MMP2 21	**77**	05	04	10
MMP21 2	**64**	36	19	04
MMP25 14	15	**92**	02	09
MMP28 3	22	**89**	09	08
MMP29 22	16	**88**	02	11
MMP26 29	21	**87**	02	14
MMP30 7	22	**86**	03	14
MMP27 12	27	**82**	08	22
MMP9 24	06	00	**93**	02
MMP10 17	08	- 02	**89**	08
MMP8 16	03	05	**88**	08
MMP11 1	00	03	**85**	11
MMP12 18	09	00	**70**	07
MMP7 9	06	10	**49**	04
MMP13 10	12	05	03	**81**
MMP17 27	31	23	19	**76**
MMP16 30	24	17	12	**75**
MMP14 8	25	24	17	**75**

Extraction Method Principal Component Analysis Rotation Method Varimax with Kaiser Normalization (Rotation converged in 5 iterations)

8 5 MMP factor content and scale reliability

In order to clearly identify the conceptual meaning of each factor, an examination of the content of each of the items contained in each factor was carried out The following section examines the content of each of the items remaining in the factor analysis and explores how the conceptual relationships between items inform us of the conceptual meaning of each factor

Factor 1 Intrinsic and Internal Self-concept motivation provision

Factor one sees the integration of the intrinsic motivation provision with the internal self-concept motivation provision As motivators these can be distinguished in the MMS However as provisions they are indistinguishable, at least among the cohort under examination in the current study The statements contained in factor one are presented in table 8 5 1

Table 8.5 1 MMP scale items for Factor 1 Intrinsic and Internal Self-concept motivation provision

MMP1/19	The work I do in my current job gives me a sense of enjoyment
MMP2/21	I do this job because I enjoy the work
MMP3/15	I get a sense of enjoyment from the activities I engage in, in this job
MMP4/28	I find the work I do in this organisation enjoyable
MMP5/5	I enjoy the work I do here
MMP6/11	The job I do here allows me to enjoy my work
MMP20/23	This job gives me a great sense of personal achievement
MMP21/2	This job allows me the freedom to realise my potential
MMP23/26	The work I do here gives me a sense of personal satisfaction
MMP24/20	I find this job challenging and personally satisfying

It is important to note that the statements that make up the MMS are 'idealized' or 'hypothetical' in nature, requiring participants to make personal values judgments about their motivational drivers In contrast the MMP requires respondents to make value judgments on statements of 'fact' relating to their work environment and the work that they do It may be that enjoyment (or intrinsic motivation) is a natural by-product of the provision for internal self-concept based motivation Consequently while an individual may not seek or be motivated by the provision for intrinsic based motivation, this provision may be a naturally occurring byproduct of the satisfaction of internally self-concept based motivation This is merely a hypothetical explanation

of this finding What is clear is that the current cohort does not distinguish between the intrinsic enjoyment that may be gamed from engaging in a particular task and the sense of satisfaction and achievement that is got from task completion Despite the incongruity between these findings and the clear delineation of motivational sources but forward by the meta-theory of motivation (Leonard et al , 1999), these results offer important insight into the satisfaction of motivational needs for research scientists Hitherto any reference to the Intrinsic and Internal Self-Concept motivation provision will relate directly to participants responses to the 10 items listed in table 8 5 1 An examination of the internal consistency of this scale revealed a Cronbach alpha of 0 9507 highlighting the extremely high correlation between items in this factor

Factor 2 Goal Internalization motivation provision

As intended in the initial construction of the MMP in chapter five the items contained in factor two relate to the provision of Goal Internalization motivation These scale items are presented in table 8 5 2

Table 8 5 2 MMP scale items for Factor 2 Goal Internalization motivation provision

MMP25/14	I agree with the goals and missions of this organisation
MMP26/29	I believe in what this organisation is trying to achieve
MMP27/12	I feel this organisation supports my values and beliefs
MMP28/3	The values of this organisation are in line with my personal values
MMP29/22	I believe in the mission and goals of this organisation and work hard to help realise them
MMP30/7	The goals of this organisation are reflected in my personal goals

The items presented in table 8 5 2 show a clear relationship to the concept of goal internalization The importance of the congruence between organizational and

individual goals and the drive to attain those goals are central to Leonard et al's (1999) description of the goal internalization motive Future references to the Goal Internalization motivation provision will relate specifically to participant's responses to the 6 items listed in table 8 5 2 An examination of the internal consistency of this scale revealed a Cronbach alpha of 0 9577

Factor 3 Instrumental motivation provision

The scale items that comprise factor three relate to the motivational provision of Instrumental motivation, as intended by the initial construction of the MMP The six items that emerged under this factor are presented in table 8 5 3 A respondent's satisfaction with the financial rewards and salary associated with their employment position relates directly to the concept of instrumental motivation as described by Leonard et al (1999) The internal consistency of this scale is also quite high yielding a Cronbach alpha of 0 8867

Table 8 5 3 MMP scale items for Factor 3 Instrumental motivation provision

MMP7/9	This salary I receive here is comparable to other jobs of this type
MMP8/16	This job pays well for the work I do
MMP9/24	I am satisfied with the financial rewards of this position
MMP10/17	This job provides me with adequate financial reward
MMP11/1	The salary I receive is a fair reflection of the work I do
MMP12/18	The salary I receive in this job is sufficient to meet my needs

Factor 4 External Self-Concept Motivation

Finally factor four contains four scale items which are conceptually related to the

provision of Leonard at al's (1999) External Self-concept motivation These items together with items MMP15 13 and MMP18 25 represent the original scale items devised during initial MMP construction However while items MMP15 13 & MMP18 25 did relate sufficiently strongly to factor 4 they also related reasonably well with factor 2 (Goal Internalization Motivation Provision) Consequently, to aid in identifying and ensuring the conceptual clarity of the factors, they were removed

Table 8 5 4 MMP scale items for Factor 4 External Self-concept motivation

MMP13/10	I feel my colleagues approve of my work behaviour
MMP14/8	My colleagues recognise when I have done a good job
MMP16/30	I believe I have the respect and admiration of my peers
MMP17/27	The hard work I do here is recognised by my work colleagues

An examination of the internal consistency of the items in this scale revealed a Cronbach alpha of 0 8573

8 6 Organisational Culture Survey scale reliability

The Organizational Culture Survey (Glaser et al , 1987) was designed to operationalise culture within the confines of a standardized questionnaire The instrument measures six dimensions of the organizational environment that are known to be of importance when considering the impact that the organization has on scientific research effectiveness (Hurley, 1997, Mouly & Sankaran, 1998) The six factors contained within the OCS include Teamwork, Morale, Information Flow, Involvement, Supervision, and Meetings

The instrument is well constructed with principal-component factor analysis yielding a six-factor solution with eigenvalues in excess of 1 0 In addition no items in the

scales had a item loading less than 0 56 (Rubin et al , 1994) Glaser et al (1987) reported scale reliabilities ranging from 63 to 91 using Cronbach's alpha However to ensure suitability for use with the current study, independent examinations of the Cronbach alpha for each subscale were conducted Table 8 6 1 lists the Cronbach alpha reliabilities for each subscale of the OCS for the current sample of research scientists

Table 8 6 1 OCS subscale Cronbach alpha reliabilities for sample of participants in current study (N=329)

SUBSCALE	CRONBACH ALPHA
Teamwork	0 8627
Morale	0 9032
Information Flow	0 7791
Involvement	0 7775
Supervision	0 8813
Meetings	0 7544

In addition to the six subscales contained within the OCS, another measurement scale was included with the administration of the OCS This subscale, developed by Conway (2003), was designed to assess the effectiveness of selection procedures within an organisation The five items that make up this scale yielded a Cronbach alpha reliability coefficient of 0 6839 This was the only scale of the measurement instrument known as the OCS Revised that was below the recommended scale reliability of 0 7 for research instruments This scale together with the subscales of the OCS allow for the measurement of important aspects of the organisational environment

The moderate to strong reliability coefficients of these scales supports their use in the current study

8 7 Validity of the measure of Self-evaluation of Research Profile and Performance

The measurement and evaluation of scientific productivity is a complex and sensitive area How we define performance, evaluate quality over quantity, and quantify the potential value of scientific outputs all add to the complexity of this issue What is clear, when examining the literature on the measurement of scientific performance, is that there is no one universally acceptable or agreed upon measure

As describe previously in the Methodology chapter seven the rational behind the use of the Higher Education & Research Opportunities, Research Assessment Exercise (REA), for sample selection and as an organisational measure of performance was based on several factors The REA incorporates a wide range of evaluation criteria in its estimation of research performance, including such factors as research outputs, students and studentships, policies, evidence of esteem, and external research income REA scores allow for the categorisation of researchers within their departments from 5* to 1 As the aggregate score for a department is based on the submission of each research active member it is not unreasonable to equate the highest-ranking departments with the highest-quality research staff

In addition to its usefulness as a 'performance' measure the REA scores also facilitated stratification across performance levels during the sample selection phase of the study In practical terms the REA measure allows for the identification of researchers at various levels of performance within specific research domains, across

a large number of institutions However this 'group' labelling of research performance does not take into account individual differences, variations in performance levels among researchers in the same departments that may result from factors such as experience, ability, age, gender, personality, qualification, or personal circumstance Consequently, and in order to be able to adequately examine the hypotheses of the current study at the appropriate unit of analysis (the individual), an individual measure of research performance was required for each participant This need led to the development of the Self-evaluation of Research Profile and Performance (SERPP), described in chapter six While many of the issues of validity were addressed during construction, some features of the instrument such as its empirical criterion validity and empirical representative reliability could not be examined until a sufficiently large response set had been gathered

Following the data collection phase of the current study analyses were conducted to examine criterion validity comparing the SERPP scores against REA scores, and representative reliability examining known differences across groups The REA scores (5* to1) for research departments are based on the aggregation of individual submission across a department Consequently one would expect that even allowing for individual differences and variation the aggregation of SERPP scores for participants who took part in the REA would correspond to the REA scores for that department This examination of criterion validity was conducted by comparing the mean scores for participants from each department against the REA scores for that department It is important to note that only those participants who identified themselves as having their work included in their departments REA submission were included in this analysis As the 'International' level was the most senior and

important evaluation level on the SERPP, participant's scores to this element of the SERPP were compared with the REA scores

Table 8 7 1 Participants mean scores for 'International Level' on SERPP across REA departmental scores

DEPARTMENTAL REA SCORES	SCIENTISTS MEAN SCORES FOR 'INTERNATIONAL LEVEL' ON SERPP	NUMBER OF PARTICIPANTS IN EACH GROUP	STANDARD DEVIATION
3b	2 6316	19	9551
3a	3 1176	68	9228
4	3 3000	70	1 0265
5	3 5614	57	9640
5*	3 8393	56	1 0579

It is important to note that while the full range of REA departmental scores range from 5* to 1, in practice very few departments are ranked at the lower level It is probable that departments likely to rank at this level would not participate in the REA exercise, as the expenditure of time and resources required for submission would not be justified against the very low levels of research funding they would be awarded as a result

A cursory examination of table 8 7 1 shows that the mean scores of 'international level' on the SERPP increase as the departmental scores increase However to ensure that the relationship is statistically significant a Pearson correlation was carried out

Table 8 7 2 Pearson correlation for participants mean scores for 'International Level' on SERPP and REA departmental scores

		REA	INTSERPP
REA	Pearson Correlation	1	987
	Sig (1-tailed)		**001**
	N	5	5
'International level' SERPP	Pearson Correlation	987	1
	Sig (1-tailed)	**001**	
	N	5	5

As can be seen from table 8 7 2 the relationship is significant at the 001 level, offering evidence in support of the criterion validity of the SERPP and the expected relationship between SERPP scores and REA scores It should be noted that the correlation of scores between groups and aggregated means of individual scores is, from a strictly statistical perspective, inappropriate The reader should not presume that the almost perfect correlation between these scores identifies an almost prefect relationship between individual and group scores Rather this analysis was conducted to illustrate from a conceptual point of view the strength and validity of the hypothesised relationship between RAE group scores and the Mean of combined individual scores for individuals that make up that particular group In this case SERPP ratings at the international level of performance were treated as scale, rather than ordinal data While this approach is not strictly statistically appropriate, given the relatively large number of respondents it is conceptually appropriate for illustrative purposes

In addition to this empirical measure of validity, an additional measure of representative reliability was examined The concept of representative reliability is based on the ability of an instrument to identify known differences across groups Ryan (2003) reports a consistent relationship between scientific performance and age, with performance increasing as age increase and then dropping off slightly in the 60's and later years The ability to identify this relationship through the analysis of data from the current study using data collected using the SERPP and a biographical measure of participant age would lend support to the representative reliability of the SERPP

Typically the relationship between age and scientific productivity displays an inverted U shaped relationship dropping off much more gradually than it rose Since the ranges under which participants in the current study categorised themselves end at '*60+*' it is not expected that the typically identified decline in performance will be present in the graphical illustration of age versus research performance Consequently what should be observed is a steady increase of 'international level' SERPP scores as age increases to the maximum '*60+*' category included in the current study

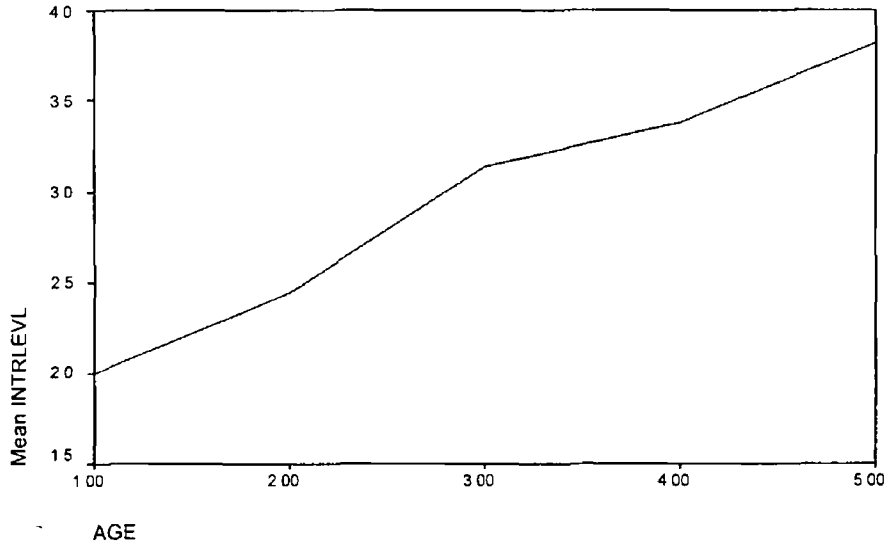


Figure 8 7 1 Graph of Age versus participant responses to 'international level' on the SERPP

Figure 8 7 1 clearly illustrates the increase in 'international level' SERPP responses with age, as predicted This finding further strengthens the case for the SERPP as a reliable instrument, fit for use in the current study

8 8 Conclusion

In conclusion, the preceding chapter presents and describes the validity and reliability of all instruments used in the current study While these instruments were found to be reasonable and sufficiently robust to allow for further analysis of the data, several

important aspects of the findings from this chapter should be noted

With regard to the MMS it should be noted that six, not five, factors were identified from the factor analysis of the data collected using this instrument This is in direct conflict with Leonard et al's (1999) meta-theory of motivation, but offers important insight into the motivational profile of scientists and also into the theory itself Additionally while the Cronbach reliabilities for each of the subscales of the MMS are moderate to strong, any future findings relating to the factors five and six (Internal Self-concept Motivation and Achievement Need Motivation) should be viewed with caution as the alpha reliabilities for these subscales (6726 & 6009 respectively) fall short of the conventionally accepted level for research purposes of 0 7

Again in relation to the MMP we see that the originally expected number of factors did not emerge In this instance four factors emerged rather than the expected five This incongruity exists due to the provision of Intrinsic motivation and Internal Self-concept motivation being indistinguishable among the participants in the current study This finding provides a useful insight into the provision of work motivation for scientist, and is examined further in chapters nine and ten

The instruments used to measure aspect of the organisational work environment shows reasonable reliability All subscales of the OCS (Glaser et al , 1987) have acceptable scale reliabilities as presented in table 8 5 1 However some caution should be taken when interpreting later results from Conway's (2003) selection measure as its Cronbach alpha coefficient of 6839 falls slightly short of the conventionally accepted standard of 0 7

CHAPTER NINE

RESULTS OF THE MAIN DATA COLLECTION PHASE OF THE CURRENT STUDY

9 1 Introduction

Chapter nine examines the results and main findings of the current study as they relate to the primary research goals and hypotheses laid down at the end of chapter five In addition some ancillary findings relating to trends in the data are also presented for later discussion Summary statistics relating to the sample of scientists who took part in the current study have been presented in chapter seven, while analysis of the reliability and validity of measurement instruments employed in the current study have been presented in chapter eight The presentation of these results will not be repeated here, though reference to the statistical properties of the measurement instruments, as described in chapter eight, will be made where appropriate Comments on the results presented in chapter nine are limited, as discussion of these results is primarily reserved for chapter ten

9 2 Goals and hypotheses of the current study

Following a review of the literature a model of scientific effectiveness was presented in chapter five The ability to test this model is determined by the suitable operationalisation and measurement of the variables contained within the model These needs are presented as a number of research goals that were required to be met to allow for the hypotheses of the current study to be tested These goals and hypotheses are repeated here

Research goal no 1 is 'The identification and measurement of organisational characteristics of the research environment that are believed to have an influence on scientific research effectiveness '

Research goal no 2 is 'The measurement of the degree to which scientists participating in the current study perceive their motivational sources are being provided for, i e their 'motivational provisions''

Research goal no 3 is 'The measurement and construction of a motivational profile for research scientists'

Research goal no 4 is 'The measurement of scientific research effectiveness for all scientists participating in the current study'

Hypothesis 1 'Research organisations that exhibit higher scores on measures of their organisational characteristics will exhibit higher scores on measures of research effectiveness'

Hypothesis 2 'The measurement of organisational characteristics of the research environment employed in the current study will relate directly to the measures of scientists experience of the organisations provision for motivational sources'

Hypothesis 3 'The degree of fit between measures of the scientist's experience of the motivational provisions of the research organisation and measures of the scientist's motivational sources will correlate directly with measures of scientific effectiveness'

9.3 The organisational characteristics of the research organisation

Section 9 3 deals with the investigation of research goal number one which requires 'The identification and measurement of the organisational characteristics of the research environment that are believed to have an influence on scientific research effectiveness '

As described previously the organisational characteristics of the research environment were measured using the Organizational Culture Survey (Glaser et al , 1987), with additional measurement items incorporated from Conway (2003) This instrument, named the OCS Revised, measures seven key organisational variables teamwork, morale, information flow, involvement, supervision, meetings, and selection Summary findings for each factor are presented here The individual items that make up these factors are presented in appendix G As the OCS Revised is a measure of organisational characteristics, results from the analyses of factors of this measurement instrument are presented in relation to the organisational measure of research performance used in the current study, namely the RAE rankings

It is important to note that the RAE rankings presented here are displayed as ranging from 2 to 6 The original RAE rankings of research units who took part in the current study, as reported by the Hero (2002b), range from 5* through 5, 4, 3a, and 3b

However to aid in data entry and analysis these rankings were relabelled as illustrated in table 9 1

Table 9 1 Original RAE rankings (HERO, 2002b), their corresponding numerical rankings used in the current study, and meaning of rankings

Original RAE grade (HERO, 2002b)	Relabelled grade used in the current study	RAE description of grade meaning (HERO, 2002b)
5*	6	Quality that equates to attainable levels of international excellence in more than half of the research activity submitted and attainable levels of national excellence in the remainder
5	5	Quality that equates to attainable levels of international excellence in up to half of the research activity submitted and to attainable levels of national excellence in virtually all of the remainder
4	4	Quality that equates to attainable levels of national excellence in virtually all of the research activity submitted, showing some evidence of international excellence
3a	3	Quality that equates to attainable levels of national excellence in over two thirds of the research activity submitted, possibly showing evidence of international excellence
3b	2	Quality that equates to attainable levels of national excellence in more than half of the research activity submitted

Consequently where an RAE ranking of 6 is presented in the results below, this ranking relates to an original Hero (2002b) ranking of 5* A score of 3 represents an original ranking of 3a, while a score of 2 represents an original ranking of 3b

9 3 1 Teamwork

The concept of teamwork was measured by eight items of the OCS Revised (See appendix G) The reliability of this scale was found to be 8627, as reported in chapter eight The factor represents the degree to which scientist working in their research department report that their interaction with colleagues is functional, cooperative, open, and constructive Descriptive statistics presented in table 9 2 show the mean score for Teamwork to be 3 153, with a standard deviation of 70357

Table 9 2 Descriptive statistics for variable Teamwork across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Teamwork	329	4	1	5	3 153	70357

As the Likert-type scale associated with each item of the OCS Revised ranged from a low of 1 to a high of 5, ranges for mean responses to the factor Teamwork also range from a minimum of 1 and a maximum of 5 Prior to any complex statistical analyses it is often useful to visually illustrate the data under investigation to help inform future analyses and identify potential patterns in the data Consequently figure 9 1 provides an illustration of mean teamwork scores across RAE ranked departments

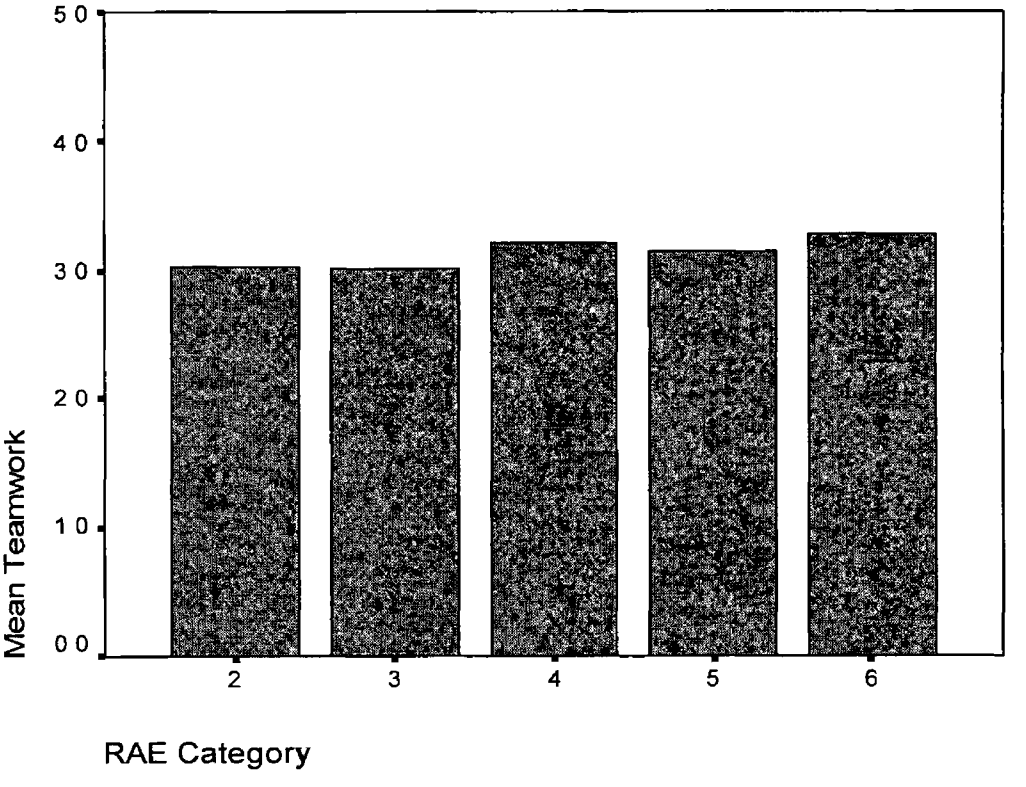


Figure 9 1 Mean Teamwork scores by RAE category

Figure 9 1 suggest that there is little difference between the reported mean scores on the variable teamwork across RAE ranked departments with all mean score falling between 3 02 and 3 28 Table 9 3 also provides mean scores for this factor across RAE ranked departments A more detailed analysis of the potential differences in reported Teamwork scores between RAE ranked departments is presented later in section 9 7 of this chapter, during the examination of hypothesis one

Table 9 3 Mean scores of OCS factor Teamwork across RAE groups

Rae group	2	3	4	5	6
Mean Teamwork Scores	3 03	3 02	3 21	3 15	3 28

9 3 2 Morale

The concept of Morale was measured by 7 items of the OCS Revised (See appendix G) The reliability of this scale was found to be a respectable 9032, as reported in chapter eight The factor represents the degree to which scientist working in their research department report good working relationships, respect for workers, fairness, trust, and organisational character Descriptive statistics presented in table 9 4 show the mean score for Morale to be 2 6891, with a standard deviation of 86451

Table 9 4 Descriptive statistics for variable Morale across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Morale	329	4	1	5	2 6891	86451

Figure 9 2 illustrates the distribution of mean scores for Morale across the various RAE rankings of participating departments

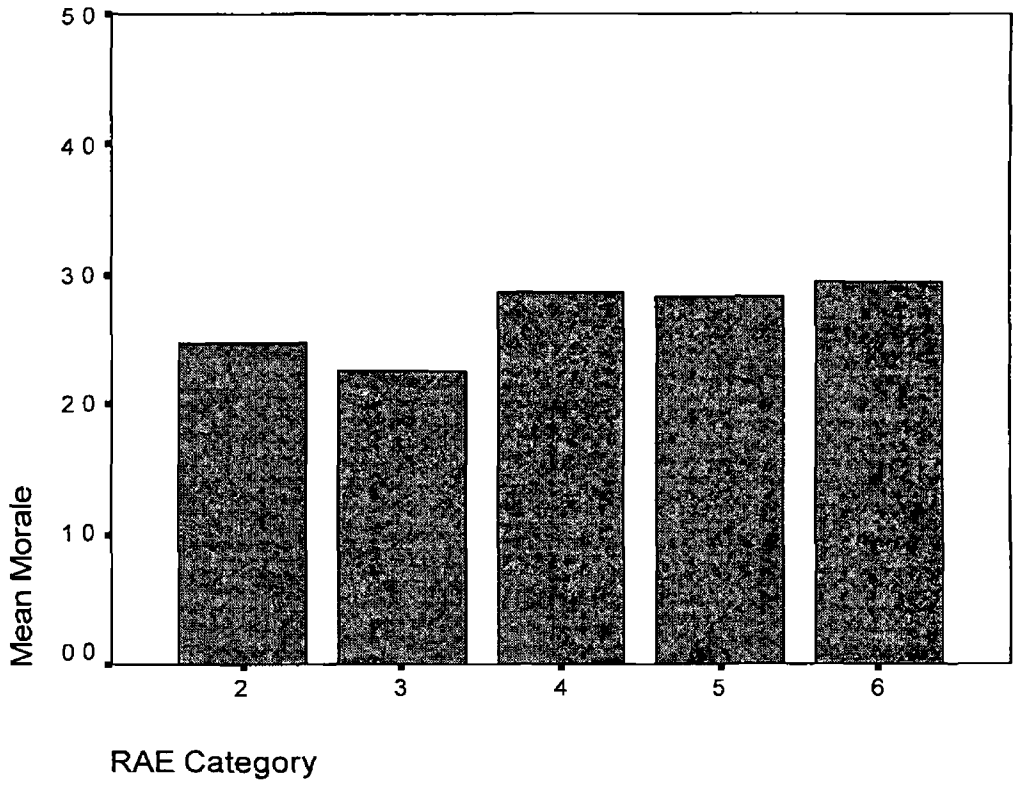


Figure 9 2 Mean Morale scores by RAE category

The graphical illustration of results presented in figure 9 2 suggests a potential difference between reported mean scores for Morale between category two and three ranked departments the higher ranked departments Table 9 5 also provides mean scores for this factor across RAE ranked departments Further analysis of the statistical significance of any potential differences between RAE ranked departments is examined in section 9 7

Table 9 5 Mean scores of OCS factor Morale across RAE groups

Rae group	2	3	4	5	6
Mean Morale Scores	2 46	2 25	2 86	2 84	2 95

9.3.3 Information Flow

The concept of Information Flow was measured by four items of the OCS Revised (See appendix G). The Cronbach alpha reliability of this scale was found to be .7791, as reported in chapter eight. The factor represents the degree to which scientist working in their research organisations report sufficient information to do one's job, communication about changes and contact with other work teams. Descriptive statistics presented in table 9.6 show the mean score for Information Flow to be 3.0409, with a standard deviation of .8199

Table 9.6 Descriptive statistics for variable Information Flow across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Information flow	330	4	1	5	3.0409	.8199

Presented in figure 9.3, is an illustration of mean scores for Information Flow across RAE grouped departments. Table 9.7 also provides mean scores for this factor across RAE ranked departments. This illustration suggests potential difference between reported Information Flow scores for category two and three RAE ranked departments and higher ranked departments, though a more detailed statistical investigation is required to identify the significance of any differences that may exist. As this section is addressing the issue of research goal number one, more detailed analysis of this factor is reserved for presentation in section 9.7 of this chapter.

Table 9.7 Mean scores of OCS factor Information Flow across RAE groups

Rae group	2	3	4	5	6
Mean Information Flow Scores	2.82	2.71	3.22	3.17	3.19

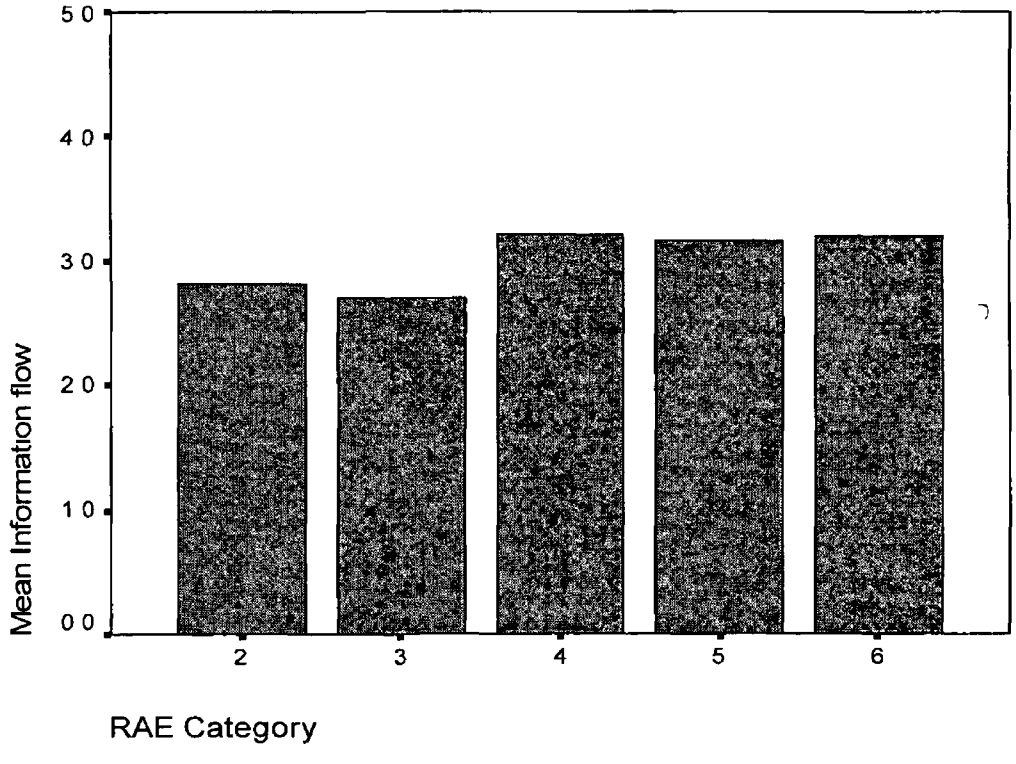


Figure 9 3 Mean Information Flow scores by RAE category

9 3 4 Involvement

The concept of Involvement was measured by four items of the OCS Revised (See appendix G) The Cronbach alpha reliability of this scale was found to be 7775, as reported in chapter eight The factor represents the degree to which scientists working in their research organisations report the degree of input in decision-making, and encouragement for contributing new thoughts and ideas Descriptive statistics presented in table 9 8 show the mean score for Involvement to be 2 9614, with a standard deviation of 8794

Table 9 8 Descriptive statistics for variable Involvement across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Involvement	330	4	1	5	2 9614	8794

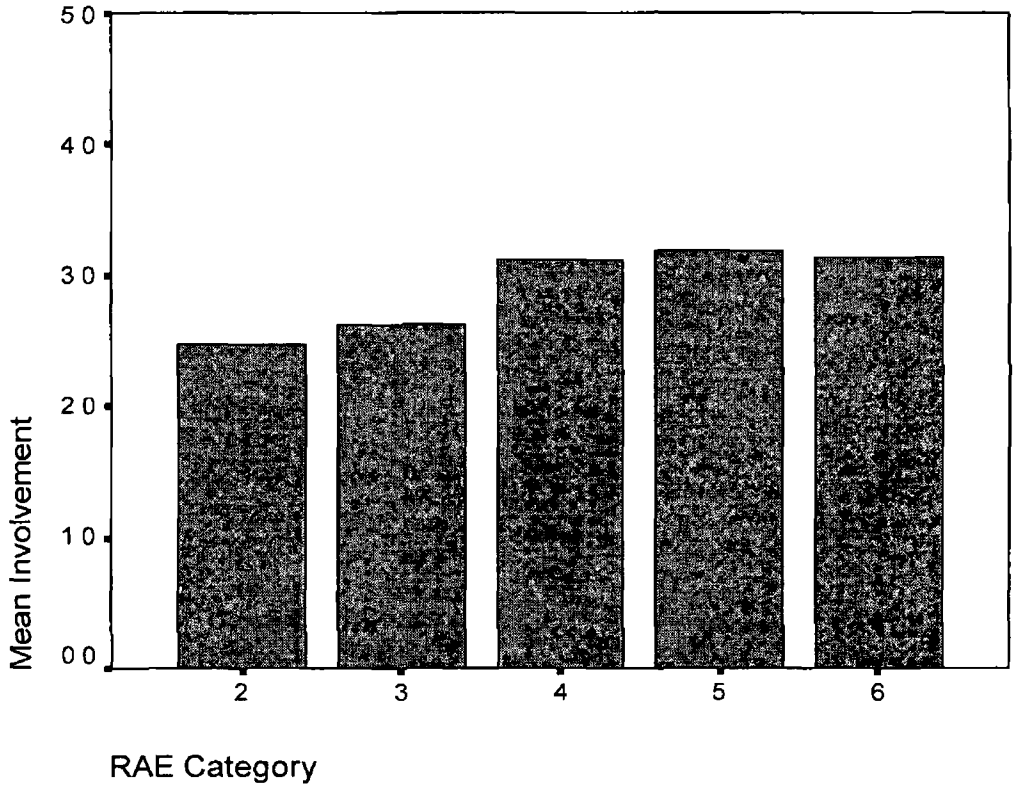


Figure 9 4 Mean Involvement scores by RAE category

The illustration of mean scores for the factor Involvement presented in figure 9 4 again suggest a potentially significant difference between some of the lower and higher ranked departments and departments ranked four, five, and six Table 9 9 also provides mean scores for this factor across RAE ranked departments Further investigation on this finding is conducted in section 9 7

Table 9 9 Mean scores of OCS factor Involvement across RAE groups

Rae group	2	3	4	5	6
Mean Involvement Scores	2 46	2 62	3 12	3 18	3 13

9.3.5 Supervision

The concept of Supervision was measured by eight items of the OCS Revised (See appendix G). The Cronbach alpha reliability of this scale was found to be .8813, as reported in chapter eight. The factor represents the degree to which scientists working in their research organisations report on the valence and clarity of supervisory feedback about their work performance. Descriptive statistics presented in table 9.10 show the mean score for Supervision to be 3.0542, with a standard deviation of .83356. It should also be noted from table 9.10 that the number of participants (N=316) is lower in this instance due to the fact that some of the respondents were supervisors, without any immediate superiors and consequently could not respond to the items in this factor.

Table 9.10 Descriptive statistics for variable Supervision across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Supervision	316	4	1	5	3.0542	.83356

Figure 9.5 suggests a potential difference between the mean Supervision scores for category 3 ranked departments and higher departments, which is examined in more detail in section 9.7. Table 9.11 also provides mean scores for this factor across RAE ranked departments.

Table 9.11 Mean scores of OCS factor Involvement across RAE groups

Rae group	2	3	4	5	6
Mean Involvement Scores	2.46	2.62	3.12	3.18	3.13

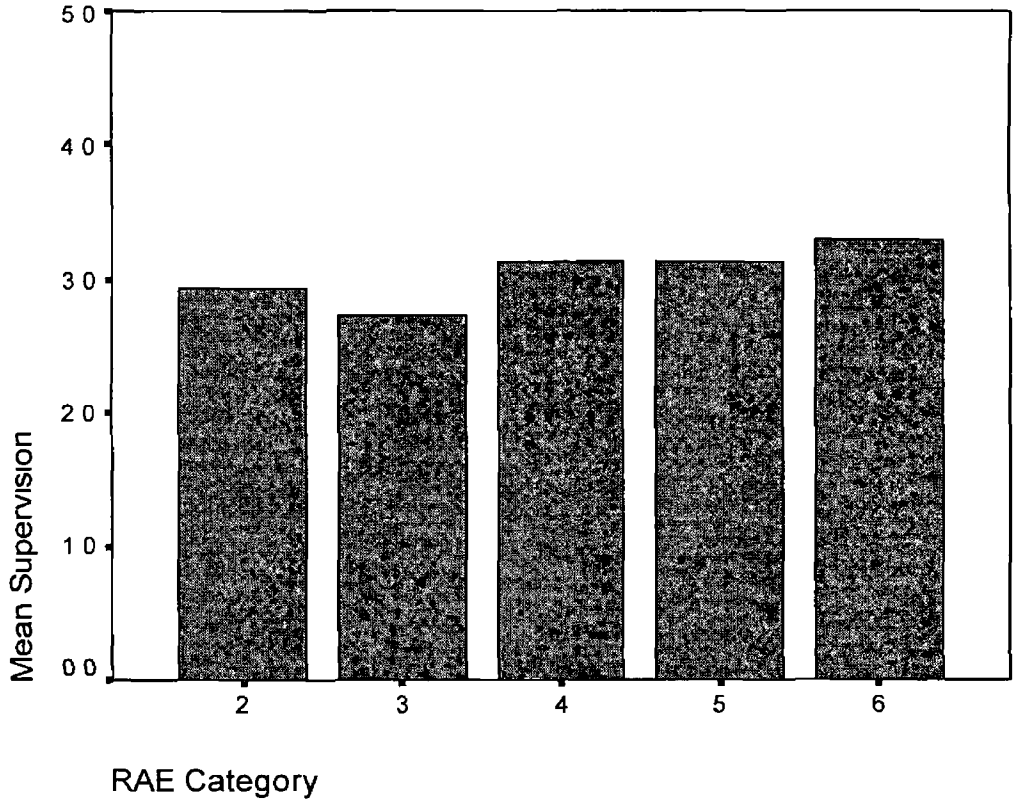


Figure 9 5 Mean Supervision scores by RAE category

9 3 6 Meetings

The concept of Meetings was measured by five items of the OCS Revised (See appendix G) The Cronbach alpha reliability of this scale was found to be an acceptable 7544, as reported in chapter eight The factor represents the degree to which scientists working in their research organisations report on how productive and democratic meetings are Descriptive statistics presented in table 9 12 show the mean score for Meetings to be 2 7488, with a standard deviation of 70494

Table 9 12 Descriptive statistics for variable Meetings across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Meetings	328	4	1	5	2 7488	70494

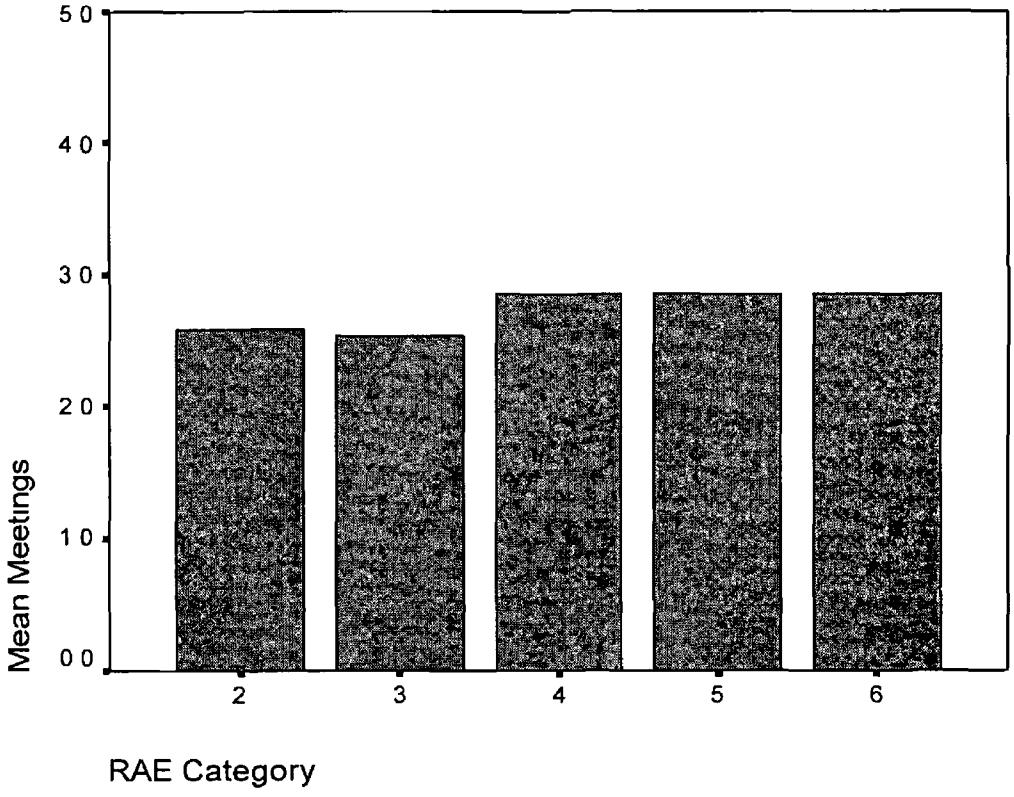


Figure 9 6 Mean Meetings scores by RAE category

Again figure 9 6 highlights a potential difference between the Mean scores for Meetings for RAE ranked categories two and three and higher categories This potential difference is examined further in section 9 7 Table 9 13 also provides mean scores for this factor across RAE ranked departments

Table 9 13 Mean scores of OCS factor Meetings across RAE groups

Rae group	2	3	4	5	6
Mean Meetings Scores	2 58	2 53	2 85	2 84	2 85

9 3 7 Selection

The concept of Selection was measured by five items of the OCS Revised (See appendix G) The Cronbach alpha reliability of this scale was found to be an unacceptable 6839, as reported in chapter eight As the Cronbach alpha reliability score for this factor is approaching an acceptable level further analysis was conducted for investigative purposes However it is important to note that ultimately this scale was found to be statistically unreliable Consequently any relationships identified using this factor should be viewed with extreme caution

The factor represents the degree to which scientists working in their research organisations report on how well new recruits to the organisation are selected and how well such individuals 'fit' with the existing organisational culture Descriptive statistics presented in table 9 14 show the mean score for Selection to be 2 9706, with a standard deviation of 66034

Table 9 14 Descriptive statistics for variable Selection across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Selection	326	4	1	5	2 9706	66034

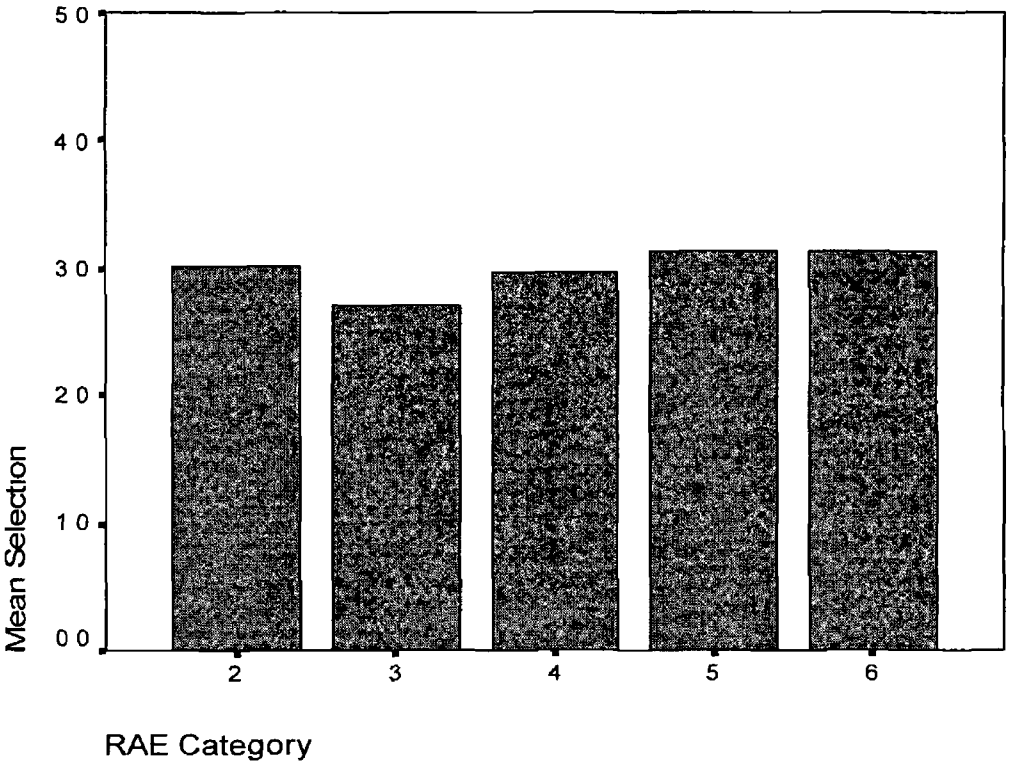


Figure 9 7 Mean Selection scores by RAE category

Figure 9 7 suggests a potentially significant difference between RAE category three ranked departments and other departments Table 9 15 displays mean scores for this factor across RAE ranked departments This potential relationship is examined in section 9 7 of this chapter, though due to its poor scale reliability results from this factor should be viewed with extreme caution

Table 9 15 Mean scores of OCS factor Selection across RAE groups

Rae group	2	3	4	5	6
Mean Selection Scores	3 00	2 69	2 97	3 13	3 13

9 3 8 Conclusion

Section 9 3 of this chapter has presented descriptive statistics for the measures of organisational characteristics used in the current study Graphical illustrations of the data have also been presented to in identifying potential patterns that may exist within the data, these illustrations are also used to inform statistical analysis and interpretation of these results in later sections In most cases the factors presented were found to be reliable The one exception to this was the factor of Selection whose Cronbach reliability coefficient was found to be unacceptably low Research goal number one requires "The identification and measurement of organisational characteristics of the research environment that are believed to have an influence on scientific research effectiveness" With the exception of the measurement of the factor Selection this research goal has been met The following section addresses the requirements of research goal number two

9 4 The measurement of motivational provisions

Research goal number two requires 'The measurement of the degree to which scientists participating in the current study perceive their motivational sources are being provided for, i e their 'motivational provisions'' This goal is essential in order to determine the interaction between the scientist's motivational sources, the organisation's motivational provisions, and the resultant effect this interaction has on scientific effectiveness, if any Initial results for the factor and scale reliability analyses conducted in chapter eight were positive, but also presented some

unexpected findings Descriptive statistics of those factors that were identified and their reported reliabilities are presented next

9 4 1 Intrinsic and Internal Self-concept motivation provision

This factor was identified by the factor analysis conducted on the MMP scale items presented in chapter eight Essentially it is an integration of the of scale items for what was originally intended to be two separate factors, Intrinsic motivation provision, and Internal Self-concept motivation provision The factor contains ten items (see table 8 4 1 chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 9507 As with the factors of the OCS Revised, descriptive statistics for MMP factors are presented here, as are graphical illustrations of the relationship between Mean scores for this factor across RAE ranked departments The RAE rankings are used as a grouping category for the examination of the factors of the MMP due to the fact that the unit of analysis that items of the MMP refer to are work/organisational factors

Descriptive statistics for this factor show a mean of 5 6897 and a standard deviation of 93016, and a response range of 5 6, from a minimum of 1 4 to a maximum of 7 This is within expected parameters as the seven-point Likert response range of items of the MMP are from 1 to 7

Table 9 16 Descriptive statistics for variable Intrinsic/Internal Self-Concept motivation provision across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Intrinsic/Internal Self-concept Provision	330	5 6	1 4	7	5 6897	90316

Figure 9 8 highlights the homogeneity of responses from participants across the RAE groupings Respondents from RAE department categories two to six show very little variation in Mean scores for this factor Mean scores for this factor across RAE groupings are displayed in table 9 17

Table 9 17 Mean scores of MMP factor Intrinsic/Internal Self-concept Provision across RAE groups

Rae group	2	3	4	5	6
Mean Intrinsic/Internal Self-concept Provision Scores	5 61	5 45	5 77	5 77	5 83

Though this initial investigation suggest no significant difference in responses to this factor across REA categories further statistical evidence of this is presented at the end of this section

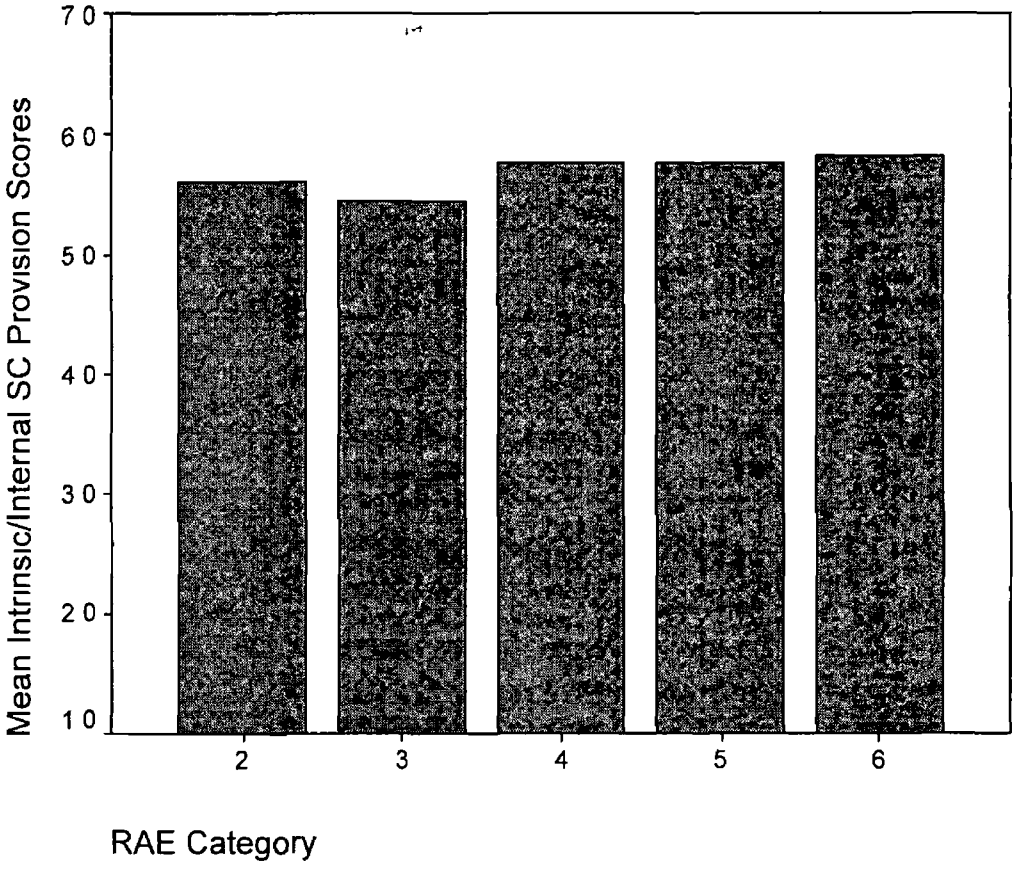


Figure 9 8 Mean Intrinsic/Internal Self-concept Provision scores by RAE category

9 4 2 Goal Internalization motivation provision

This factor was identified by the factor analysis conducted on the MMP scale items presented in chapter eight The items of this factor were designed to measure the degree to which the scientists work environment provided for the motivational sources of Goal Internalization as defined by Leonard et al (1999) The factor contains six items (see table 8 4 2, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 9577

Descriptive statistics for this factor are presented in table 9 18 and show a mean of 4 7343 and a standard deviation of 1 217 for all participant responses

Table 9 18 Descriptive statistics for variable Goal Internalization motivation provision across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Goal Internalization Provision	330	6	1	7	4 7343	1 217

Unlike figure 9 8, figure 9 9 suggests that there may be a difference between the reported level of Goal Internalization provision across the RAE categories Mean scores for this factor across RAE groupings are displayed in table 9 19

Table 9 19 Mean scores of MMP factor Goal Internalisation Provision across RAE groups

Rae group	2	3	4	5	6
Mean Goal Internalisation Provision Scores	4 60	4 28	4 80	4 91	5 05

Responses for category three are clearly lower than those of categories two, four, five and six Further analysis of this factor is present later in this section to determine the exact statistical nature of this difference

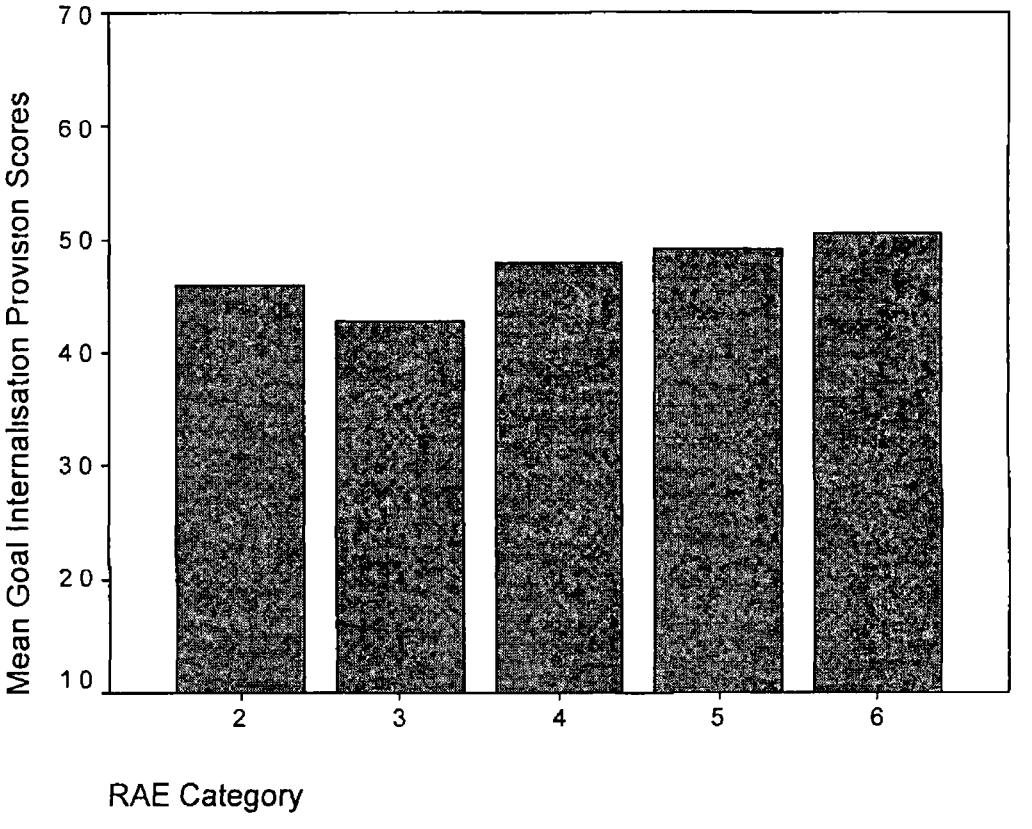


Figure 9 9 Mean Goal Internalization Provision scores by RAE category

9 4 3 Instrumental motivation provision

This factor was identified by the factor analysis conducted on the MMP scale items presented in chapter eight The items of this factor were designed to measure the degree to which the scientists work environment provided for the Instrumental needs of the organisational members, i e their salary and associated financial benefits, as defined by Leonard et al (1999) The factor contains six items (see table 8 4 3, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 8867

Descriptive statistics for this factor are presented in table 9 20 and show a mean of 3 850 and a standard deviation of 1 399 for all participant responses

Table 9 20 Descriptive statistics for variable Instrumental Motivation Provision across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
Instrumental Provision	329	6	1	7	3 850	1 399

The graphical illustration of mean scores for this factor across RAE category departments suggest that mean responses are higher for RAE category two departments than for other departmental categories Mean scores for this factor across RAE groupings are displayed in table 9 21

Table 9 21 Mean scores of MMP factor Instrumental Provision across RAE groups

Rae group	2	3	4	5	6
Mean Instrumental Provision Scores	4 38	3 85	4 04	3 71	3 66

The statistical significance of this difference is examined in more detail later in this section

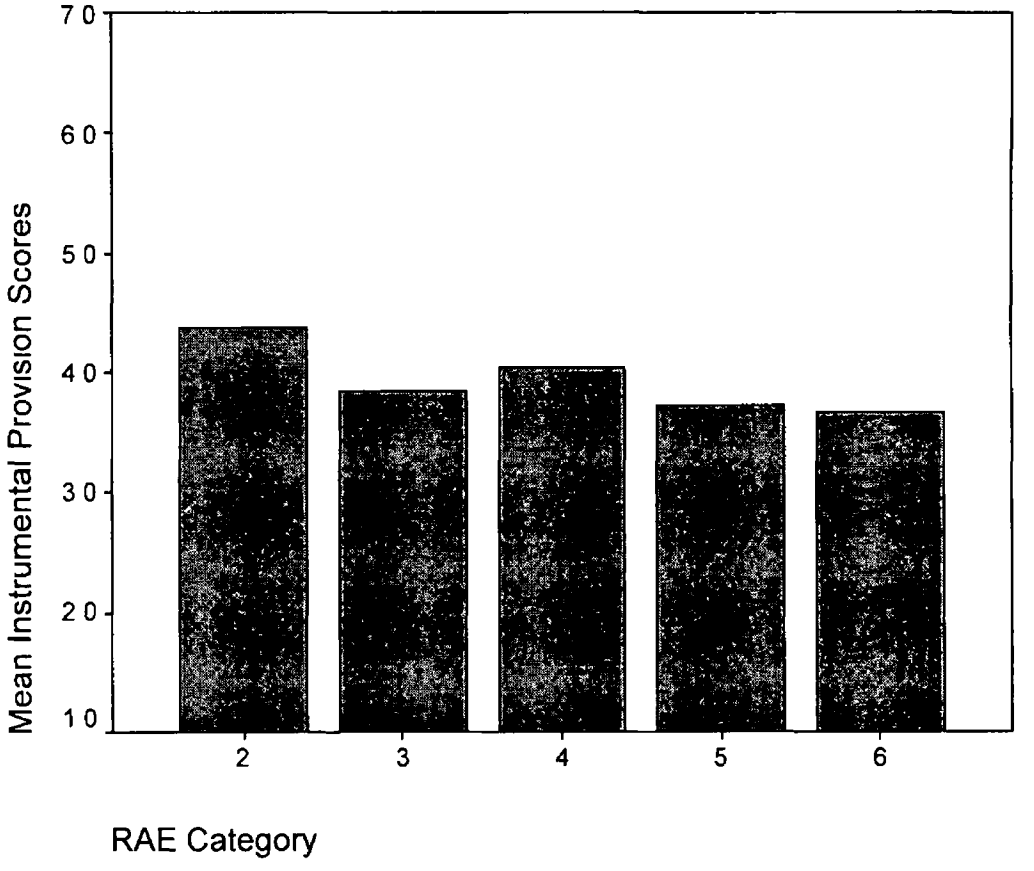


Figure 9 10 Mean Instrumental Provision scores by RAE category

9 4 4 External Self-concept Motivation Provision

This factor was identified by the factor analysis conducted on the MMP scale items presented in chapter eight The items of this factor were designed to measure the degree to which the scientists work environment provided for the external self-concept need of their organisational members, as defined by Leonard et al (1999) The factor contains four items (see table 8 4 4, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 8573

Descriptive statistics for this factor are presented in table 9 22 and show a mean of 5 1894 and a standard deviation of 95078 for all participant responses

Table 9 22 Descriptive statistics for variable External Self-concept Motivation Provision across all participating departments

	N	range	Minimum	Maximum	Mean	Standard Deviation
External Self-concept Provision	330	5 75	1 25	7	5 1894	95078

The graphical illustration of mean scores for this factor across RAE category departments suggests little difference in the mean responses between RAE category departments, though any potentially significant differences between RAE category departments are examined later in this chapter Mean scores for this factor across RAE groupings are displayed in table 9 23

Table 9 23 Mean scores of MMP factor External Self-concept Provision across RAE groups

Rae group	2	3	4	5	6
Mean External Self-concept Provision Scores	5 14	5 02	5 29	5 16	5 33

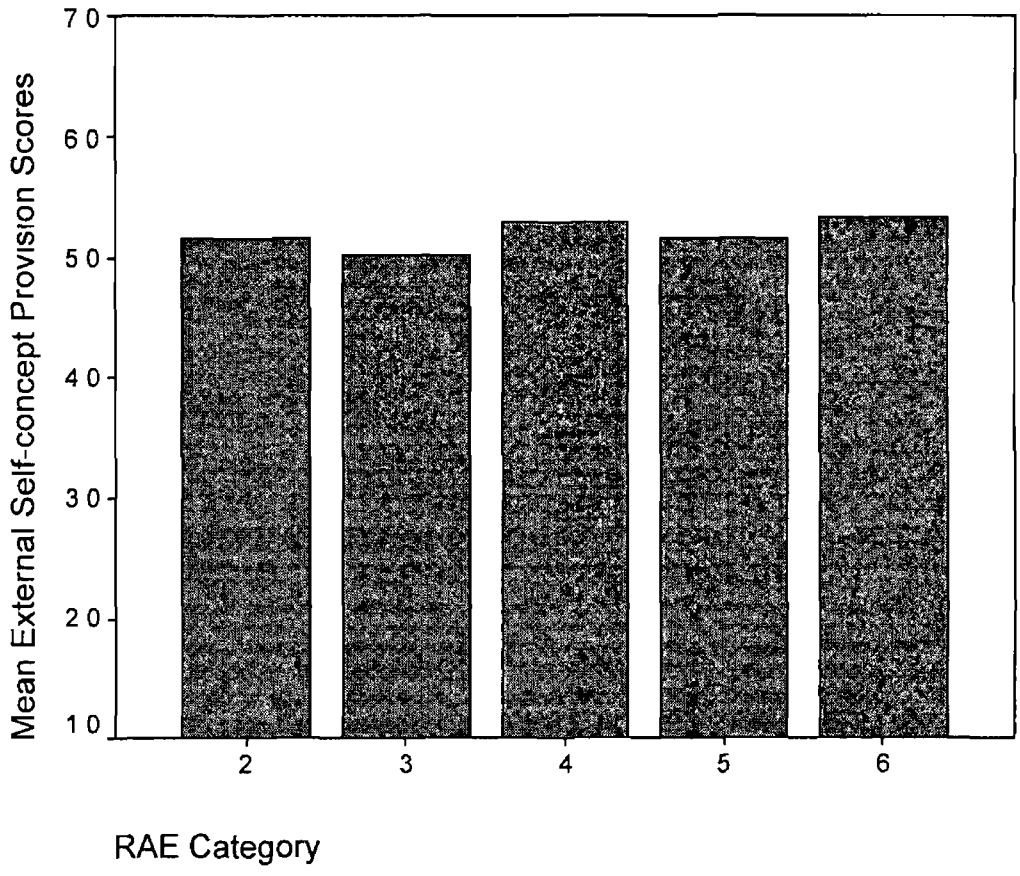


Figure 9 11 Mean External Self-concept Provision scores by RAE category

In addition to the summary information provided for results relating to the four MMP factors presented above, additional analyses was conducted on these items to determine the statistical significance of possible differences alluded to in the graphical illustrations of figures 9 8, 9 9, 9 10, and 9 11 This was done by conducting an analysis of variance (ANOVA) for the four factors of the MMP across REA categories of participant research departments Table 9 24 presents the results of this analysis

Table 9 24 ANOVA for factors of the MMP and RAE scores

Anova						
		Sum of Squares	df	Mean Square	F	Sig
External Self-concept Provision	Between Groups	4 797	4	1 199	1 332	258
	Within Groups	292 616	325	900		
	Total	297 413	329			
Instrumental Provision	Between Groups	12 676	4	3 169	1 632	166
	Within Groups	629 337	324	1 942		
	Total	642 014	328			
Goal Internalization Provision	Between Groups	28 452	4	7 113	5 038	001*
	Within Groups	458 870	325	1 412		
	Total	487 322	329			
Intrinsic/Internal Self-concept Provision	Between Groups	7 631	4	1 908	2 378	052
	Within Groups	260 734	325	802		
	Total	268 365	329			

The results presented in table 9 24 confirm that a statistically significant difference exists between RAE categories on the MMP factor of Goal Internalization provision It is also interesting to note that while the factor of Intrinsic/Internal Self-concept provision is not found to show any statistically significant difference across RAE categories the factor does approach significance, and this relationship may warrant further examination with a more conceptually sound measurement instrument

A Tukey HSD test was conducted on the MMP factor Goal Internalization provision to determine the nature of the differences that exist between the RAE categories Results are presented in table 9 25

Table 9 25 Tukey HSD test for MMP factor Goal Internalization provision, and RAE categories

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Standard Error	Sig	Lower Bound	Upper Bound
Goal Internalization Provision	2	3	3196	28890	803	- 4728	1 1121
		4	- 1964	29379	963	-1 0023	6095
		5	- 3050	29614	841	-1 1174	5073
		6	- 4496	29173	537	-1 2498	3507
	3	2	- 3196	28890	803	-1 1121	4728
		4	- 5160*	18791	050	-1 0315	- 0006
		5	- 6247*	19155	011	-1 1501	- 0992
		6	- 7692*	18466	000	-1 2758	- 2627
	4	2	1964	29379	963	- 6095	1 0023
		3	5160*	18791	050	0006	1 0315
		5	- 1087	19885	982	- 6541	4368
		6	- 2532	19223	681	- 7805	2741
	5	2	3050	29614	841	- 5073	1 1174
		3	6247*	19155	011	0992	1 1501
		4	1087	19885	982	- 4368	6541
		6	- 1445	19579	947	- 6816	3926
	6	2	4496	29173	537	- 3507	1 2498
		3	7692*	18466	000	2627	1 2758
		4	2532	19223	681	- 2741	7805
		5	1445	19579	947	- 3926	6816

Summarised Mean Scores across RAE Groupings					
RAE Group	2	3	4	5	6
Mean Goal Internalisation Provision Scores	4 60	4 28	4 80	4 91	5 05

Results of the post hoc analysis presented in table 9 25 show that participant responses to the factors Goal Internalization provision for RAE category three are significantly different to those of categories four, five and six With category three respondents showing significantly lover levels of Goal Internalization provision than their more senior colleagues

In conclusion, research goal number two required 'The measurement of the degree to which scientists participating in the current study perceive their motivational sources

are being provided for, i e their 'motivational provisions'' The results presented in the preceding section only partially meet this goal In all five motivational sources are contained with the meta-theory of motivation developed by Leonard et al (1999) However the Measure of Motivational Provisions (MMP) only identified four motivational provisions, and as the Intrinsic/Internal Self-concept is an integrated concept, only three of those are directly related to the five concepts of the meta-theory

While the reliability and conceptual validity of MMP factors for Instrumental motivation provision, External Self-concept motivation provision, and Goal Internalization motivation provision have been confirmed during this analysis the conceptual relationship between the integrated factor of Intrinsic/Internal Self-concept motivation provision identified in the current study and the originally distinct concepts of Intrinsic motivation provision and Internal Self-concept motivation provision described within the original meta-theory of motivation (Leonard et al , 1999), is not congruent This outcome has serious implications for the testing of hypotheses developed during the course of the current study, particularly hypothesis three

Hypothesis 3 'The degree of fit between measures of the scientist's experience of the motivational provisions of the research organisation and measures of the scientist's motivational sources will correlate directly with measures of scientific effectiveness'

The ramification of this failure to measure the provisions of all the motivational concepts contained within Leonard et al's (Leonard et al , 1999) meta-theory accurately is discussed further in section 9 9

9 5 The measurement of motivational sources

Research goal number three requires 'The measurement and construction of a motivational profile for research scientists' This goal is essential in order to determine the degree to which scientists are motivated by the various sources of motivation contained with Leonard et al's (1999) meta-theory of motivation, and is an integral requirement for investigating the interaction between the scientist's motivational sources, the organisation's motivational provisions, and the resultant effect this interaction may have on scientific effectiveness Initial results for these factors and scale reliability analyses were conducted in chapter eight Descriptive statistics of those factors that were identified and found to be reliable are presented next, as well as a general profile of scientists' motivational sources

9 5.1 Instrumental motivation

This factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight The items of this factor were initially designed to measure the degree to which participating scientists were motivated by Instrumental sources of motivation, as defined by Leonard et al (1999) The factor contains six items (see table 8 2 1, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 8370

Descriptive statistics for this factor are presented in table 9 26 and show a Mean of 2 2837 and a standard deviation of 9976 for all participant responses

Table 9 26 Descriptive statistics for variable Instrumental motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
Instrumental motivation	329	4 67	1 00	5 67	2 2837	99076

The mean scores for factors of the OCS Revised and the MMP showed mean scores compared with RAE groupings This was done to ensure the units of analyses and comparisons were consistent For example both the OCS Revised and the MMP measure variables at the level of the organisation However the MMS scores reported here measure individual scientist's responses to their own motivational sources Essentially this measurement takes place at the level of the individual, consequently comparative scores for MMS Mean responses are not made with the RAE categories but rather with the individual measure of scientific effectiveness developed for use in the current study, namely the Self-evaluation of Research Profile and Performance (SERPP) More specifically the grouping variable of scientific performance used here is the scientist's response to the International Level SERPP, as this is the primary measure of individual scientific research effectiveness used m the current study

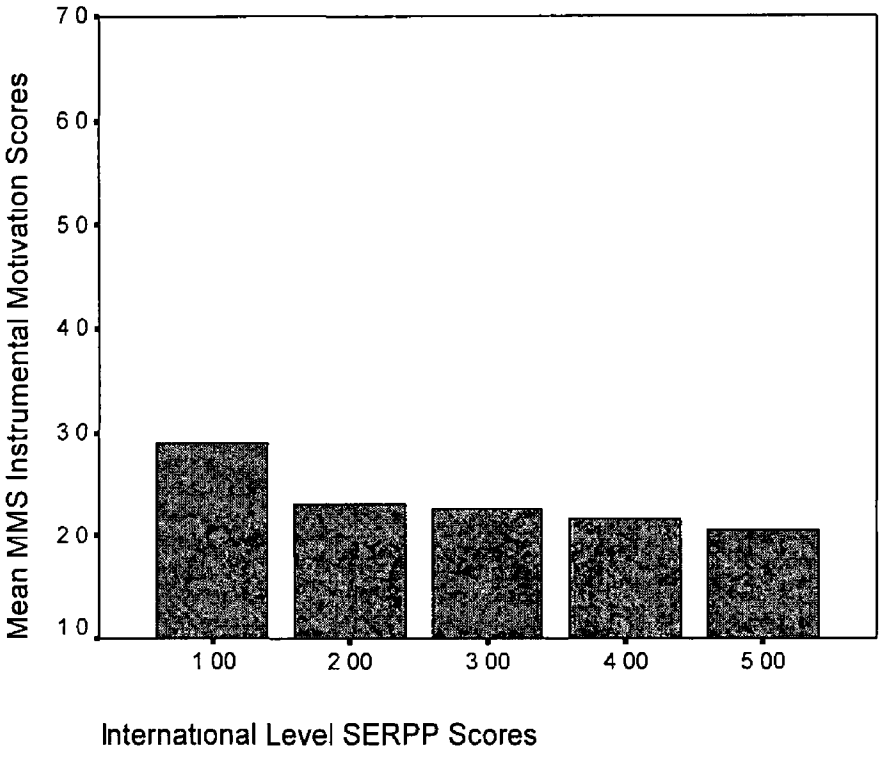


Figure 9 12 Mean Instrumental Motivation scores by International Level SERPP category

The interpretation of the graphical illustration presented in figure 9 12 suggests that a difference in Instrumental Motivation may exist between scientists on the lowest level of the SERPP, and their counterparts who have a higher research profile rating Mean scores for this factor across SERPP levels are presented in table 9 27 The statistical significance of this observation is examined further in at the end of this section

Table 9 27 Mean scores of MMS factor Instrumental Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean Instrumental Motivation Scores	2 90	2 30	2 25	2 16	2 05

9 5 2 External Self-concept motivation

This factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight The items of this factor were designed to measure the

degree to which participating scientists were motivated by external evaluation and approval from peers and superiors The factor contains five items (see table 8 2 2, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 7717

Descriptive statistics for this factor are presented in table 9 28 and show a Mean of 3 8303 and a standard deviation of 1 1234 for all participant responses

Table 9 28 Descriptive statistics for variable External Self-concept Motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
External Self-concept Motivation	330	5 20	1 00	6 20	3 8303	1 1234

A graphical illustration of mean scores for External Self-concept motivation across the various levels of research effectiveness is presented in figure 9 13 This graphical representation shows scientists with the lowest levels of research performance to have slightly elevated levels of External Self-concept motivation Mean scores for this factor across SERPP levels are presented in table 9 29 The statistical significance of this preliminary finding is examined further at the end of this section

Table 9 29 Mean scores of MMS factor External Self-concept Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean External Self-concept Motivation Scores	4 21	3 85	3 77	3 85	3 63

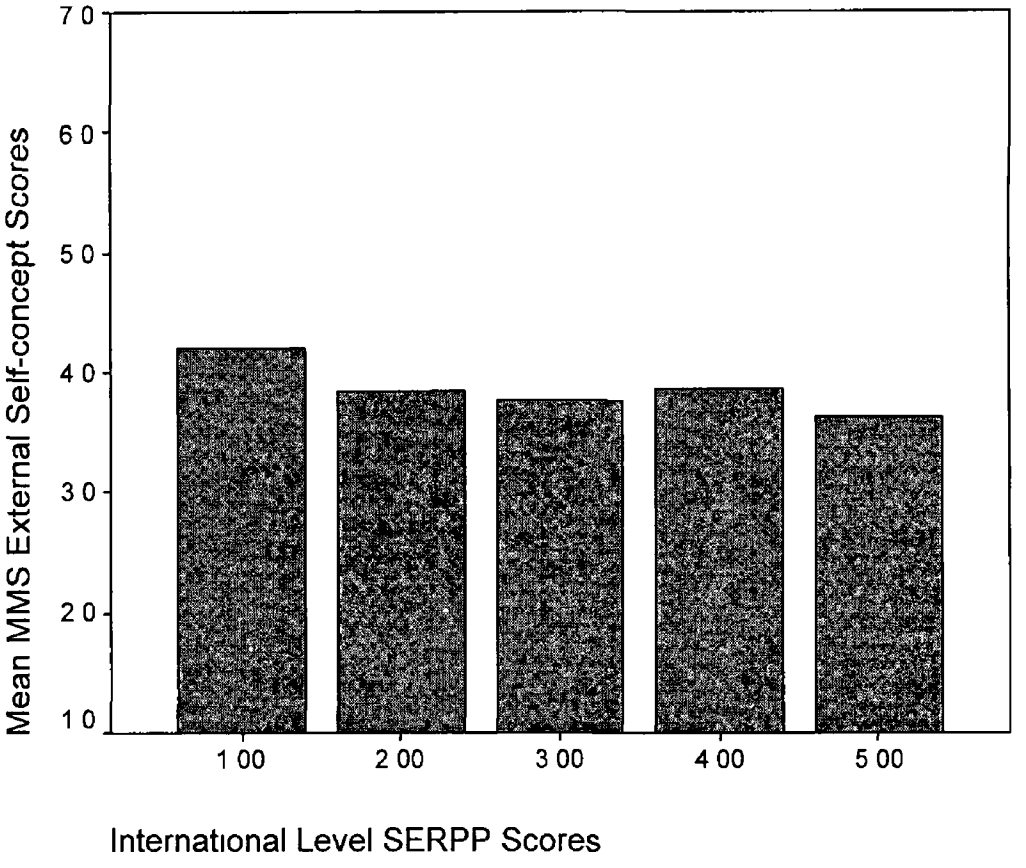


Figure 9 13 Mean External Self-concept Motivation scores by International Level SERPP category

9 5 3 Goal Internalization motivation

This factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight The items of this factor were designed to measure the importance of congruence between organizational and individual goals, as a motivator The final factor contains four items (see table 8 2 3, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 7816

Descriptive statistics for this factor are presented in table 9 30 and show a mean of 4 8951 and a standard deviation of 1 1190 for all participant responses

Table 9 30 Descriptive statistics for variable Goal Internalization motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
Goal Internalization Motivation	329	6 00	1 00	7 00	4 8951	1 1190

A graphical illustration of mean scores for Goal Internalization motivation across the various levels of research effectiveness is presented in figure 9 14 This graphical representation shows scientists with the lowest levels of research performance to have slightly lower levels of Goal Internalization motivation Mean scores for this factor across SERPP levels are presented in table 9 31 The statistical significance of this preliminary finding is examined further at the end of this section

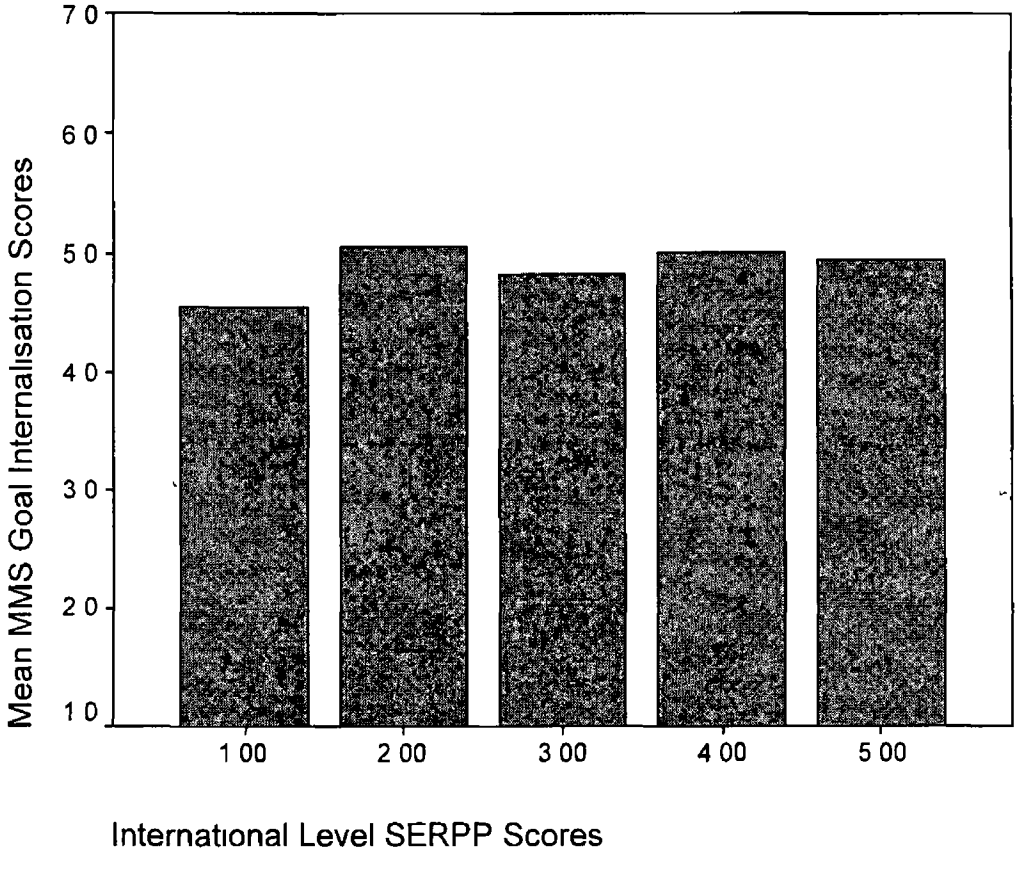


Figure 9 14 Mean Goal Internalization Motivation scores by International Level SERPP category

Table 9.31 Mean scores of MMS factor Goal Internalisation Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean Goal Internalisation Motivation Scores	4.56	5.05	4.84	5.01	4.95

9.5.4 Intrinsic motivation

This factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight. The items of this factor were designed to measure the importance of enjoyment in the work itself, as a motivator. The final factor contains five items (see table 8.2.4, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of .6977. This Cronbach alpha coefficient is below the generally acceptable standard of 0.7 for research purposes. However as it is approaching an acceptable level results for this scale are presented here. Although results are presented, they should be viewed with extreme caution and scepticism.

Descriptive statistics for this factor are presented in table 9.32 and show a Mean of 4.6474 and a standard deviation of 1.0065 for all participant responses.

Table 9.32 Descriptive statistics for variable Intrinsic Motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
Intrinsic Motivation	329	5.60	1.00	6.60	4.6474	1.0065

A graphical illustration of mean scores for Intrinsic motivation across the various levels of research effectiveness is presented in figure 9.15. This graphical representation shows little difference between scientists across levels of research

effectiveness Mean scores for this factor across SERPP levels are presented in table 9 33 A more detailed statistical examination of this factor is presented at the end of this section

Table 9 33 Mean scores of MMS factor Intrinsic Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean Intrinsic Motivation Scores	4 59	4 83	4 62	4 61	4 64

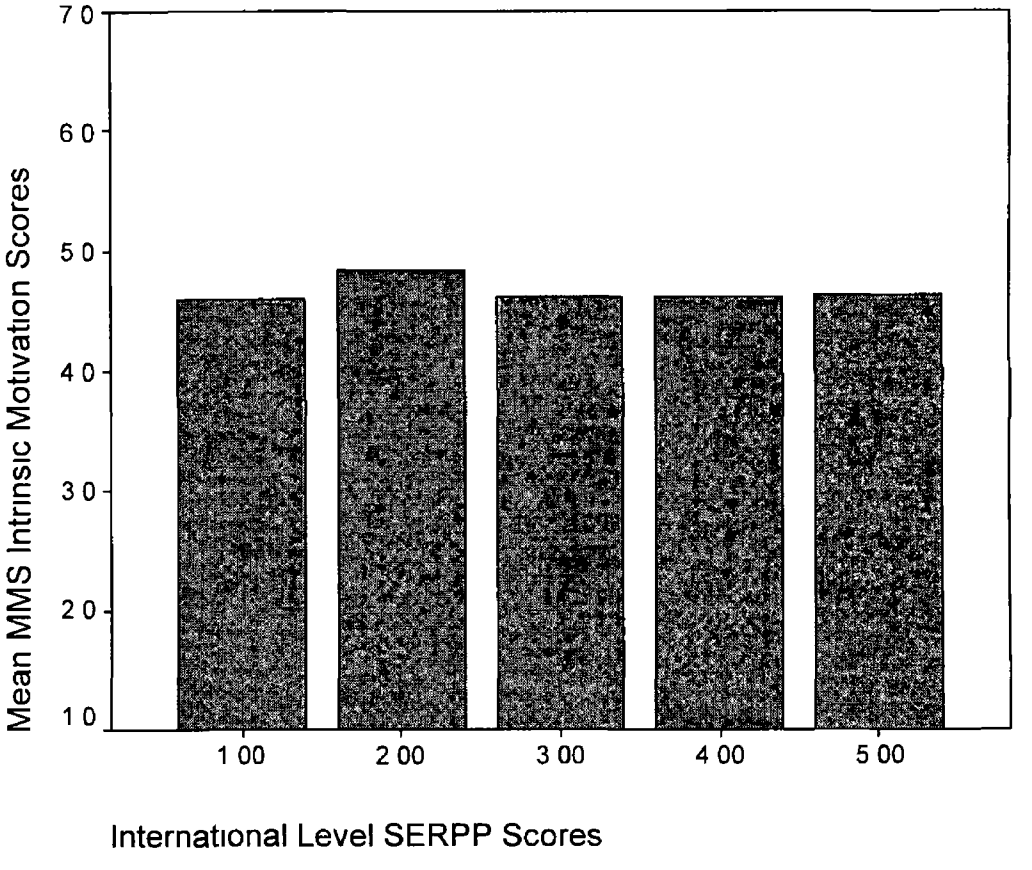


Figure 9 15 Mean Intrinsic Motivation scores by International Level SERPP category

9 5 5 Internal Self-concept motivation

This factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight The items of this factor were initially designed to measure the degree to which participants are motivated by the 'personal' nature and relation of the work to the individual, and their ability to identify their work with their own standards, and values The final factor contains four items (see table 8 2 5, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 6726 This Cronbach alpha coefficient is below the generally acceptable standard of 0 7 for research purposes Although results for this scale are presented here, they should be viewed with extreme caution and scepticism

Descriptive statistics for this factor are presented in table 9 34 and show a mean of 6 2409 and a standard deviation of 1 0065 for all participant responses

Table 9 34 Descriptive statistics for variable Internal Self-concept Motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
Internal Self-concept Motivation	330	2 75	4 25	7 00	4 6474	51452

The relatively small range of responses on this scale, and it's relatively small standard deviation suggest a high degree of homogeneity in participant responses to this factor

The graphical illustration of mean scores for Internal Self-concept motivation across the various levels of research effectiveness presented in figure 9 16, suggest that scientists at the lowest level of research effectiveness may have lower levels of

Internal Self-concept motivation than there more effective colleagues Mean scores for this factor across SERPP levels are presented in table 9 35 This finding is examined in more detail at the end of this section However the reader is again warned as to the validity and reliability of these results due to the poor Cronbach reliability of the scale used to measure this factor

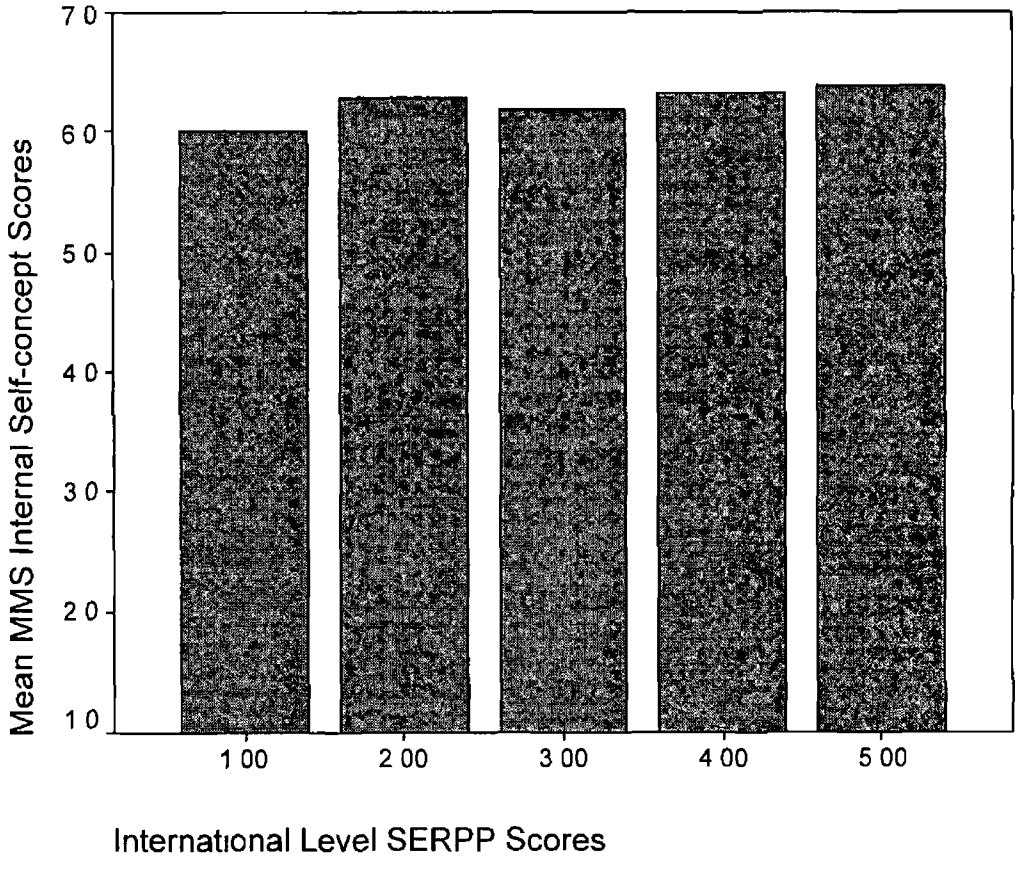


Figure 9 16 Mean Internal Self-concept Motivation scores by International Level SERPP category

Table 9 35 Mean scores of MMS factor Internal Self-concept Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean Internal Self-concept Motivation Scores	6 01	6 29	6 19	6 33	6 38

9 5 6 Achievement Need Motivation

The identification of six factors from the factors analysis conducted on the MMS data set does not correspond with the original aim of MMS construction, which was to construct an instrument to measure the five factors identified in the meta-theory of motivation However the identification of this factor was deemed to be significant, and its descriptive results are presented here The factor was identified by the factor analysis conducted on the MMS scale items presented in chapter eight The factor contains only two items (see table 8 2 6, chapter eight), and was found to have a Cronbach alpha scale reliability coefficient of 6009 This Cronbach alpha coefficient is well below the generally acceptable standard of 0 7 for research purposes However as it's identification is of significance to the meta-theory of motivation developed by Leonard et al (1999) results are presented Considering the factors weak statistical reliability, results should be viewed with extreme caution

Descriptive statistics for this factor are presented in table 9 36 and show a mean of 6 4394 and a standard deviation of 56301 for all participant responses

Table 9 36 Descriptive statistics for variable Achievement Need motivation across all participating scientists

	N	range	Minimum	Maximum	Mean	Standard Deviation
Intrinsic Motivation	330	5 00	2 00	7 00	6 4394	56301

The graphical illustration of mean scores for Achievement Need motivation across the various levels of research effectiveness presented m figure 9 17 suggests little difference between scientists across levels of research effectiveness

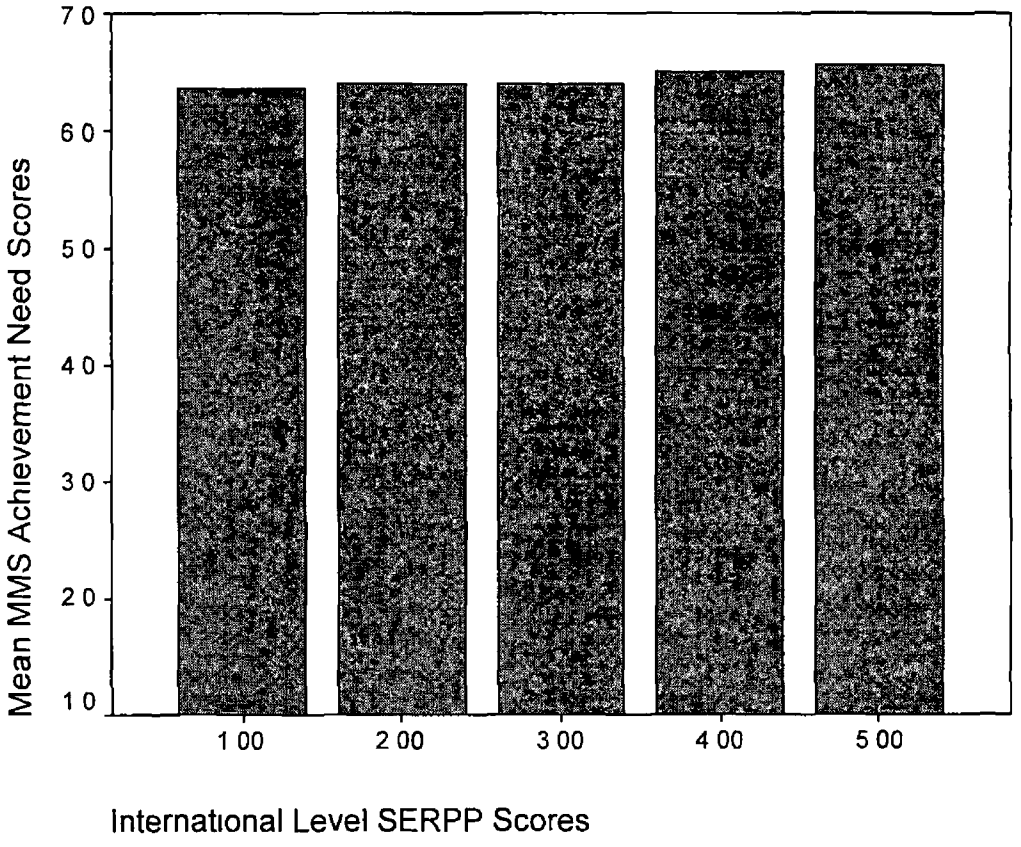


Figure 9 17 Mean Achievement Need Motivation scores by International Level SERPP category

Mean scores for this factor across SERPP levels is presented in table 9 37

Table 9 37 Mean scores of MMS factor Achievement Need Motivation across SERPP levels

SERPP level	1	2	3	4	5
Mean Achievement Need Motivation Scores	6 36	6 40	6 40	6 50	6 56

9 5 7 The motivational profile of research scientists

The second research goal of the current study was the construction of a profile of scientists motivations This was required in order to understand the factors that motivate a scientist to engage in scientific research and relative strength of these factors in relation to each other Figure 9 18 represents a general profile of scientists'

motivations for the participant sample of the current study This figure represents mean scores for all participants on each of the six factors measured using the MMS

In general terms this illustration suggests that the Achievement Need and Internal Self-concept motivation are the strongest motivators for this sample of scientists Unfortunately these are also two of the MMS factors that were found to have unacceptably low scale reliabilities

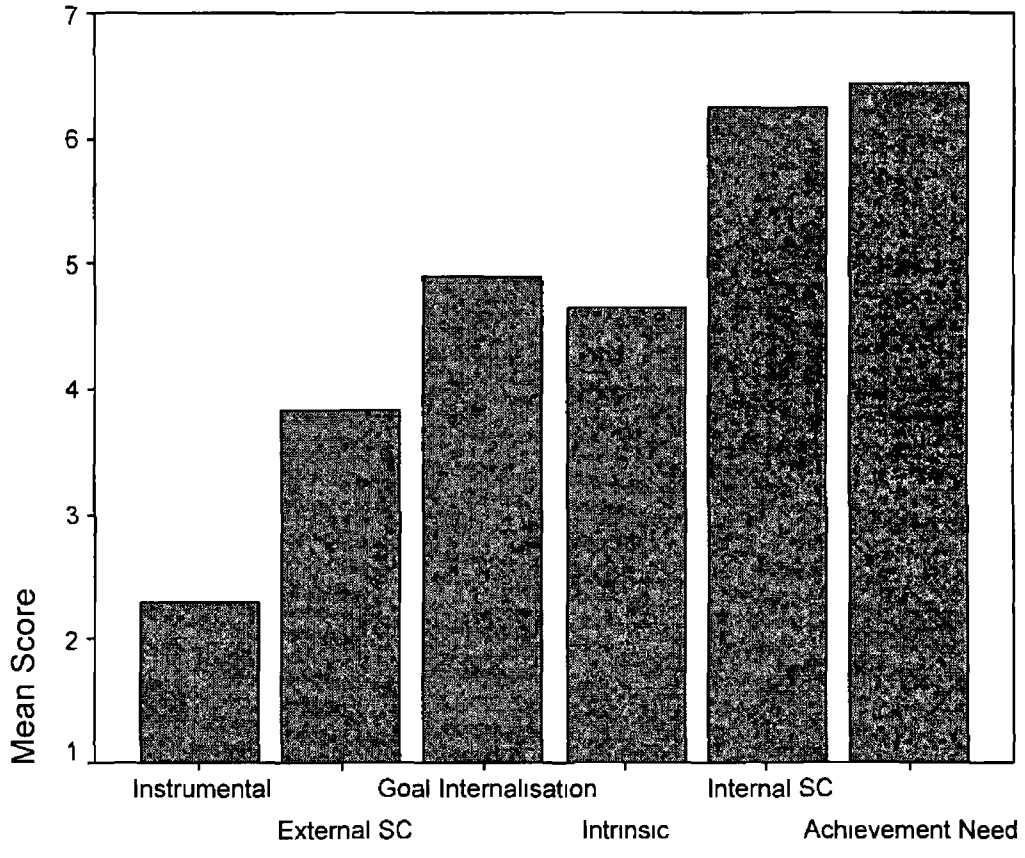


Figure 9 18 Scientists Motivational Profile Mean scores on each factor for all participating scientists

Figure 9 18 represents a general profile for all scientists who participated in the current study In order to determine if differences exist among the motivational profile of scientists with varying levels of research effectiveness an ANOVA was conducted on the motivational sources of scientists across levels of research effectiveness The

measure of research effectiveness used here is the scientist's scores on the International Level SERPP Results of this analysis are presented in table 9 38

Table 9 38 ANOVA for MMS factors and International level SERPP scores

Anova						
		Sum of Squares	df	Mean Square	F	Sig
Instrumental Motivation	Between Groups	17 146	4	4 286	4 556	001*
	Within Groups	304 821	324	941		
	Total	321 967	328			
External Self-concept Motivation	Between Groups	7 294	4	1 823	1 453	216
	Within Groups	407 923	325	1 255		
	Total	415 217	329			
Goal Internalization Motivation	Between Groups	6 685	4	1 671	1 340	255
	Within Groups	404 073	324	1 247		
	Total	410 757	328			
Intrinsic Motivation	Between Groups	1 922	4	480	471	757
	Within Groups	330 378	324	1 020		
	Total	332 300	328			
Internal Self-concept Motivation	Between Groups	3 771	4	943	3 677	006*
	Within Groups	83 327	325	256		
	Total	87 098	329			
Achievement Need Motivation	Between Groups	1 438	4	359	1 136	339
	Within Groups	102 850	325	316		
	Total	104 288	329			

The results presented in table 9 38 show that a significant difference exists across levels of research effectiveness for sources Internal Self-concept motivation and

Instrumental motivation Tukey HSD tests were conducted on these factors to determine the nature of these differences Results are presented in tables 9 39 and 9 40

Table 9 39 Tukey HSD test for MMS Factor Internal Self-concept Motivation, and International Level SERPP score

						95% Confidence Interval	
Dependent Variable	(I) SERPP International Level	(J) SERPP International Level	Mean Difference (I-J)	Standard Error	Sig	Lower Bound	Upper Bound
Internal Self-Concept Motivation	1	2	- 2742	11268	109	- 5832	0349
		3	- 1716	09586	381	- 4346	0914
		4	- 3114*	10105	019	- 5886	- 0342
		5	- 3703*	11565	013	- 6875	- 0530
	2	1	2742	11268	109	- 0349	5832
		3	1026	08741	767	- 1372	3424
		4	- 0373	09307	995	- 2926	2181
		5	- 0961	10875	903	- 3944	2022
	3	1	1716	09586	381	- 0914	4346
		2	- 1026	08741	767	- 3424	1372
		4	- 1398	07181	295	- 3368	0572
		5	- 1987	09122	191	- 4489	0516
	4	1	3114*	10105	019	0342	5886
		2	0373	09307	995	- 2181	2926
		3	1398	07181	295	- 0572	3368
		5	- 0588	09666	974	- 3240	2063
	5	1	3703*	11565	013	0530	6875
		2	0961	10875	903	- 2022	3944
		3	1987	09122	191	- 0516	4489
		4	0588	09666	974	- 2063	3240

Summarised Mean Scores across SERPP levels					
SERPP Level	1	2	3	4	5
Mean Internal Self-concept Motivation Scores	6 01	6 29	6 19	6 33	6 38

Table 9 40 Tukey HSD test for MMS Factor Instrumental Motivation, and International Level SERPP score

						95% Confidence Interval	
Dependent Variable	(I) SERPP International Level	(J) SERPP International Level	Mean Difference (I-J)	Standard Error	Sig	Lower Bound	Upper Bound
Instrumental Motivation	1	2	5938*	21584	049	0017	1 1859
		3	6441*	18363	005	1404	1 1479
		4	7335*	19392	002	2015	1 2655
		5	8494*	22154	001	2416	1 4571
	2	1	- 5938*	21584	049	-1 1859	- 0017
		3	0503	16745	998	- 4090	5097
		4	1397	17868	936	- 3504	6299
		5	2556	20832	736	- 3159	8270
	3	1	- 6441*	18363	005	-1 1479	- 1404
		2	- 0503	16745	998	- 5097	4090
		4	0894	13806	967	- 2893	4681
		5	2053	17474	766	- 2741	6846
	4	1	- 7335*	19392	002	-1 2655	- 2015
		2	- 1397	17868	936	- 6299	3504
		3	- 0894	13806	967	- 4681	2893
		5	1159	18553	971	- 3931	6248
	5	1	- 8494*	22154	001	-1 4571	- 2416
		2	- 2556	20832	736	- 8270	3159
		3	- 2053	17474	766	- 6846	2741
		4	- 1159	18553	971	- 6248	3931

Summarised Mean Scores across SERPP levels					
SERPP Level	1	2	3	4	5
Mean Instrumental Motivation Scores	2 90	2 30	2 25	2 16	2 05

The results presented in tables 9 39 and 9 40 suggest that the scientists at the lowest levels of research effectiveness have lower levels of Internal Self-concept motivation than their peers at research effectiveness levels four and five They also have higher levels of Instrumental motivation than their more effective colleagues

While these findings are of some interest the relative usefulness of a profile such as the one presented in figure 9 18 is limited due to the poor reliability of some of the scales of the MMS

In conclusion to this section, research goal number three required 'The measurement and construction of a motivational profile for research scientists' This goal is essential in order to determine the degree to which scientists are motivated by the various sources of motivation contained with Leonard et al's (1999) meta-theory of motivation, and is an integral requirement for investigating the interaction between the scientist's motivational sources, the organisation's motivational provisions, and the resultant effect this interaction may have on scientific effectiveness In all five motivational sources are contained with the meta-theory of motivation developed by Leonard et al (1999) However the Measure of Motivational Sources (MMS) identified six distinct factors, as described in chapter eight

While the reliability and conceptual validity of MMS factors for Instrumental Motivation, External Self-concept Motivation, and Goal Internalization Motivation have been confirmed, the results of the current study pose serious concerns for the integrity of the scales that measure Intrinsic Motivation, Internal Self-concept Motivation, and Achievement Need Motivation This outcome has serious implications for the testing of hypotheses developed during the course of the current study, particularly hypothesis three The implications of this outcome are discussed again in section 9 9 of this chapter

9 6 The measurement of scientific research effectiveness

Research goal number four requires the adequate measurement of scientific research effectiveness for all participants m the current study In fact due to the nature of the

variables contained within the model developed during the course of the current study, two measures of scientific research effectiveness were required One at the micro-level of the individual, and one at the more macro level of the research unit/department

At the macro-level a pre-existing and readily identifiable measure was utilised in the current study This was the Research Assessment Exercise (RAE) score discussed in chapters seven and eight At the level of the individual a new measure of research effectiveness was required As the stages employed in the development of this instrument, and the validation of this instrument has been discussed in chapters six and eight respectively, they are not repeated here At this stage it is sufficient to note that research goal number four 'The measurement of scientific research effectiveness for all scientists participating in the current study', was adequately met

9 7 The organisation and scientific effectiveness

Having examined descriptive results relating to the four main research goals of the current study, it is now possible to examine the hypotheses derived from the model developed during the course of the current study and originally presented in chapter five The first of these hypotheses to be examined is hypothesis 1
'Research organisations that exhibit higher scores on measures of their organisational characteristics will exhibit higher scores on measures of research effectiveness'

This statement predicts a positive linear relationship between the characteristics of the research organisation and its levels of research effectiveness In order to test this hypothesis a one-tailed Pearson correlation was conducted on participant responses to factors of the OCS Revised and RAE scores for the participating departments These results are presented m table 9 41 Results identify significant between group differences for all factors of the OCS revised and RAE scores

Table 9 41 Summary of Pearson correlations for OCS Revised factors and RAE scores for participating research departments

OCS Revised Factor		Research Assessment Exercise
Teamwork	Pearson Correlation□	**128***
	Sig (1-tailed)□	010
	N	329□
Morale	Pearson Correlation□	**275****
	Sig (1-tailed)□	000
	N	329□
Information Flow	Pearson Correlation□	**.208****
	Sig (1-tailed)□	000
	N	330□
Involvement	Pearson Correlation□	**250****
	Sig (1-tailed)□	000
	N	330□
Supervision	Pearson Correlation□	**217****
	Sig (1-tailed)□	000
	N	316□
Meetings	Pearson Correlation□	**167****
	Sig (1-tailed)□	001
	N	328□
Selection	Pearson Correlation□	**212****
	Sig (1-tailed)□	000
	N	326□

* correlation is significant at the 0 05 level (1-tailed)
** correlation is significant at the 0 01 level (1-tailed)

Despite the statistical significance of the results, the correlations present in table 9 41 are all very low This suggests that while there is a relationship between the organisational characteristics of the research organisation measured here and the

organisations level of research effectiveness this relationship is quite weak, pointing to the need to examine alternative predictors of research effectiveness

A regression model for the organisational characteristics of the OCS Revised and the RAE measure of scientific research effectiveness further highlights the weakness in the relationships identified in table 9 41 A linear regression model was constructed using the RAE score as a dependent variable and the organisational characteristics of teamwork, morale, information flow, involvement, supervision, meetings and selection, as independent variables Results are presented in table 9 42

Table 9 42 Regression coefficients for organisational characteristics predictors of RAE scores

Variable	Standardised coefficient	t	Significance
Teamwork	- 095	-1 210	227
Morale	260	2 286	023*
Information Flow	- 073	- 736	462
Involvement	069	670	503
Supervision	126	1 643	101
Meetings	- 041	- 481	631
Selection	052	661	509

The results presented in table 9 42 identify the factor Morale as the single statistically significant predictor of the RAE scores of research effectiveness The weakness of the relationships is also highlighted by summary statistics of the goodness-of-fit of the regression model examined here The R value of 301 represents a weak model with very little predictive ability

Table 9 43 Goodness-of-fit model summary for RAE scores and organisational characteristics

Model	R	R Squared	Adjusted R Squared	Standard Error of the Estimate
1	301	091	070	1 221

In addition to the Pearson correlations, and regression model conducted on RAE scores and the factors of the OCS Revised further examinations were conducted to examine in more detail the nature of differences and similarities that exist among the factors of the OCS Revised, across the various scores of the RAE Potential differences between RAE grouped departments were identified earlier in this chapter through the graphical illustration of mean scores for OCS Revised factors presented in figures, 9 1, through 9 7 These graphs illustrate a potential difference in these factors across RAE categories, but also suggest that the nature of these differences may not be linear The preliminary findings are examined further using a one-way classification ANOVA (Analysis of Variance) This statistical procedure determines if significant difference exists between the mean sores of factors across groups In this instance the grouping variable is the RAE categories for participating departments Results of the ANOVA are presented in table 9 44

Table 9 44 ANOVA for factors of the OCS Revised and RAE scores

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig
Teamwork	Between Groups	3 450	4	863	1 759	137
	Within Groups	158 915	324	490		
	Total	162 365	328			
Morale	Between Groups	26 763	4	6 691	9 927	000**
	Within Groups	218 376	324	674		
	Total	245 138	328			
Information Flow	Between Groups	15 911	4	3 978	6 298	000**
	Within Groups	205 286	325	632		
	Total	221 198	329			
Involvement	Between Groups	22 427	4	5 607	7 854	000**
	Within Groups	232 017	325	714		
	Total	254 445	329			
Supervision	Between Groups	13 806	4	3 451	5 235	000**
	Within Groups	205 063	311	659		
	Total	218 869	315			
Meetings	Between Groups	6 961	4	1 740	3 614	007**
	Within Groups	155 539	323	482		
	Total	162 500	327			
Selection	Between Groups	10 327	4	2 582	6 308	000**
	Within Groups	131 390	321	409		
	Total	141 717	325			

ANOVA results presented in table 9 44 show that significant differences do exist between the mean scores of the OCS Revised across RAE groups for all but one of the OCS Revised factors To further examine the nature of these differences a post hoc

analysis was conducted A multiple comparison Tukey HSD (honestly significant difference) test was employed to determine where exactly the differences lay in the original findings of the ANOVA Results are presented in table 9 45

Table 9 45 Tukey HSD test for OCS Revised Factor Morale, and RAE departments

						95% CONFIDENCE INTERVAL	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Morale	2	3	2130	19961	823	- 3346	7606
		4	- 3946	20299	296	- 9514	1623
		5	- 3757	20496	356	- 9379	1866
		6	- 4850	20156	116	-1 0379	0679
	3	2	- 2130	19961	823	- 7606	3346
		4	- 6076*	12983	000	- 9637	- 2514
		5	- 5886*	13289	000	- 9532	- 2241
		6	- 6980*	12759	000	-1 0480	- 3480
	4	2	3946	20299	296	- 1623	9514
		3	6076*	12983	000	2514	9637
		5	0189	13791	1 000	- 3594	3972
		6	- 0904	13281	961	- 4548	2739
	5	2	3757	20496	356	- 1866	9379
		3	5886*	13289	000	2241	9532
		4	- 0189	13791	1 000	- 3972	3594
		6	- 1093	13581	929	- 4819	2632
	6	2	4850	20156	116	- 0679	1 0379
		3	6980*	12759	000	3480	1 0480
		4	0904	13281	961	- 2739	4548
		5	1093	13581	929	- 2632	4819
Summarised Mean Scores across RAE Groupings							
RAE Group			2	3	4	5	6
Mean Morale Scores			2 46	2 25	2 86	2 84	2 95

Results presented in table 9 45 show that Morale scores of RAE category three departments are significantly lower than the Morale scores of RAE categories four, five and six departments If we consider this findings in conjunction with the admittedly weak, but significant, correlation between Morale and researcher effectiveness identified previously one might expect that Morale scores for RAE category two departments would also be lower than the category four, five and six departments At this point it is important to note some disparity that exists between

the number of respondents within each of the RAE categories The numbers of participant scientists in each RAE are presented in table 9 46

Table 9 46 Number of participating scientists in each RAE category

RAE category	Number of participating scientists in each category N
2	21
3	87
4	74
5	68
6	79

As we can see from the figures presented in table 9 46 the number of participant responses that make up the overall response for factors examined in RAE category is only 21 This is significantly lower than the number of participant responses in other categories, and may have a significant influence on results relating to this RAE category

Similar findings relating to differences in OCS Revised mean scores for factors Information Flow, Involvement, Supervision, and Meetings, between RAE category three and categories four, five and six are presented in tables 9 47, 9 48, 9 49, and 9 50

Table 9 47 Tukey HSD test for OCS Revised factor Information Flow, and RAE departments

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Information Flow	2	3	1145	19323	976	- 4155	6446
		4	- 3948	19651	264	- 9338	1443
		5	- 3452	19807	409	- 8886	1981
		6	- 3716	19513	317	- 9069	1637
	3	2	- 1145	19323	976	- 6446	4155
		4	- 5093*	12568	001	- 8541	- 1646
		5	- 4598*	12812	004	- 8112	- 1083
		6	- 4861*	12351	001	- 8250	- 1473
	4	2	3948	19651	264	- 1443	9338
		3	5093*	12568	001	1646	8541
		5	0495	13300	996	- 3153	4144
		6	0232	12857	1 000	- 3295	3759
	5	2	3452	19807	409	- 1981	8886
		3	4598*	12812	004	1083	8112
		4	- 0495	13300	996	- 4144	3153
		6	- 0264	13096	1 000	- 3856	3329
	6	2	3716	19513	317	- 1637	9069
		3	4861*	12351	001	1473	8250
		4	- 0232	12857	1 000	- 3759	3295
		5	0264	13096	1 000	- 3329	3856
Summarised Mean Scores across RAE Groupings							
RAE Group			2	3	4	5	6
Mean Information Flow Scores			2 82	2 71	3 22	3 17	3 19

Results show significant difference between RAE group three scores on the measure of Information Flow, and RAE groups four, five and six

Table 9 48 Tukey HSD test for OCS Revised factor Involvement, and RAE departments

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Involvement	2	3	- 1593	20543	938	- 7228	4042
		4	- 6540*	20891	016	-1 2270	- 0809
		5	- 7169*	21057	007	-1 2945	- 1392
		6	- 6623*	20744	013	-1 2313	- 0933
	3	2	1593	20543	938	- 4042	7228
		4	- 4947*	13362	002	- 8612	- 1282
		5	- 5576*	13621	001	- 9312	- 1840
		6	- 5030*	13131	001	- 8632	- 1428
	4	2	6540*	20891	016	0809	1 2270
		3	4947*	13362	002	1282	8612
		5	- 0629	14140	992	- 4508	3250
		6	- 0083	13669	1 000	- 3833	3666
	5	2	7169*	21057	007	1392	1 2945
		3	5576*	13621	001	1840	9312
		4	0629	14140	992	- 3250	4508
		6	0546	13922	995	- 3273	4365
	6	2	6623*	20744	013	0933	1 2313
		3	5030*	13131	001	1428	8632
		4	0083	13669	1 000	- 3666	3833
		5	- 0546	13922	995	- 4365	3273
Summarised Mean Scores across RAE Groupings							
RAE Group			2	3	4	5	6
Mean Involvement Scores			2 46	2 62	3 12	3 18	3 13

Results show significant differences between RAE group two and three scores on the measure of Involvement, and RAE groups four, five and six

Table 9 49 Tukey HSD test for OCS Revised factor Supervision, and RAE departments

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Supervision	2	3	1981	19835	856	- 3462	7423
		4	- 1992	20139	860	- 7517	3534
		5	- 2020	20382	859	- 7613	3572
		6	- 3571	20047	386	- 9072	1929
	3	2	- 1981	19835	856	- 7423	3462
		4	- 3972*	13077	022	- 7561	- 0384
		5	- 4001*	13449	026	- 7691	- 0311
		6	- 5552*	12937	000	- 9102	- 2003
	4	2	1992	20139	860	- 3534	7517
		3	3972*	13077	022	0384	7561
		5	- 0029	13893	1 000	- 3841	3783
		6	- 1580	13398	763	- 5256	2096
	5	2	2020	20382	859	- 3572	7613
		3	4001*	13449	026	0311	7691
		4	0029	13893	1 000	- 3783	3841
		6	- 1551	13761	792	- 5327	2224
	6	2	3571	20047	386	- 1929	9072
		3	5552*	12937	000	2003	9102
		4	1580	13398	763	- 2096	5256
		5	1551	13761	792	- 2224	5327

Summarised Mean Scores across RAE Groupings					
RAE Group	2	3	4	5	6
Mean Supervision Scores	2 93	2 74	3 13	3 14	3 29

Results show significant difference between RAE group three scores on the measure of Supervision, and RAE groups four, five and six

Table 9 50 Tukey HSD test for OCS Revised factor Meetings, and RAE departments

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Meetings	2	3	0507	16891	998	- 4126	5141
		4	- 2731	17158	504	- 7438	1976
		5	- 2602	17324	562	- 7355	2150
		6	- 2722	17037	500	- 7396	1952
	3	2	- 0507	16891	998	- 5141	4126
		4	- 3238*	11003	029	- 6257	- 0220
		5	- 3109*	11261	048	- 6199	- 0020
		6	- 3229*	10814	025	- 6196	- 0263
	4	2	2731	17158	504	- 1976	7438
		3	3238*	11003	029	0220	6257
		5	0129	11657	1 000	- 3069	3327
		6	0009	11226	1 000	- 3071	3089
	5	2	2602	17324	562	- 2150	7355
		3	3109*	11261	048	0020	6199
		4	- 0129	11657	1 000	- 3327	3069
		6	- 0120	11479	1 000	- 3269	3029
	6	2	2722	17037	500	- 1952	7396
		3	3229*	10814	025	0263	6196
		4	- 0009	11226	1 000	- 3089	3071
		5	0120	11479	1 000	- 3029	3269
Summarised Mean Scores across RAE Groupings							
RAE Group			2	3	4	5	6
Mean Meetings Scores			2 58	2 53	2 85	2 84	2 85

Results show significant difference between RAE group three scores on the measure of Meetings, and RAE groups four, five and six

Results of Tukey HSD test for OCS Revised factor Selection shows a significant difference between responses for category three, and categories five and six These results are presented in table 9 51 However the reader is again warned as to the validity of these results due to the poor scale reliability of the items used to measure this factor

Table 9 51 Tukey HSD test for OCS Revised factor Selection, and RAE departments

						95% Confidence Interval	
Dependent Variable	(I) RAE	(J) RAE	Mean Difference (I-J)	Std Error	Sig	Lower Bound	Upper Bound
Selection	2	3	3165	15573	253	- 1107	7437
		4	0393	15818	999	- 3947	4732
		5	- 1228	15972	939	- 5610	3153
		6	- 1177	15750	945	- 5498	3143
	3	2	- 3165	15573	253	- 7437	1107
		4	- 2772	10144	051	- 5555	0010
		5	- 4393*	10382	000	- 7241	- 1545
		6	- 4342*	10038	000	- 7096	- 1589
	4	2	- 0393	15818	999	- 4732	3947
		3	2772	10144	051	- 0010	5555
		5	- 1621	10747	558	- 4569	1328
		6	- 1570	10415	558	- 4427	1287
	5	2	1228	15972	939	- 3153	5610
		3	4393*	10382	000	1545	7241
		4	1621	10747	558	- 1328	4569
		6	0051	10647	1 000	- 2870	2972
	6	2	1177	15750	945	- 3143	5498
		3	4342*	10038	000	1589	7096
		4	1570	10415	558	- 1287	4427
		5	- 0051	10647	1 000	- 2972	2870
Summarised Mean Scores across RAE Groupings							
RAE Group			2	3	4	5	6
Mean Selection Scores			3 00	2 69	2 97	3 13	3 13

The results presented in the previous tables are significant in that they identify difference in organisational characteristics between RAE grouped departments They also offer some insight into the relative weakness of the results reported in Pearson correlations and the regression model in tables 9 41 and 9 42, as these statistical procedures examine linear relationships between variables Results of the ANOVA suggest that the relationship may not be linear This, quite significant finding is discussed further in chapter ten

To conclude this section, the results present previously offer support for hypothesis 1 'Research organisations that exhibit higher scores on measures of their organisational characteristics will exhibit higher scores on measures of research effectiveness'

While the methodological design of this study does not allow for the identification of causality among the variables under examination, the identification of correlations between factors does offer some support to hypothesis one

However while the hypothesis was supported, the relative weakness of the correlations reported here suggest that the relationship between organisational characteristics and research effectiveness may not be a linear one and that additional factors not examined here may also play a significant role in influencing scientific effectiveness A more detailed interpretation and the implications of these results are discussed in chapter ten

9 8 The organisation and motivational provisions

The model of scientific effectiveness developed during the course of the current study proposes a direct link between the organisational characteristics of the research organisation as measured by the OCS Revised, and scientists experience of the degree to which their motivational needs are provided for by their organisation This relationship is reflected in hypothesis 2 'The measurement of organisational characteristics of the research environment employed in the current study will relate directly to the measures of scientists experience of the organisations provision for motivational sources'

In order to test this hypothesis a number of regression models were constructed to determine the relationship between the organisational characteristics measured using the OCS Revised and the motivational provisions measured using the MMP

The first MMP factor examined here is that of the Intrinsic/Internal Self-concept motivational provision As described in chapter eight this factor is an amalgamation of two of the factors in Leonard et al's (1999) meta-theory of motivation that was identified during the factor analysis of MMP items The results for regression are presented in table 9 52

Table 9 52 Regression coefficients and model summary for organisational characteristics of the OCS Revised and MMP factor Intrinsic/Internal Self-concept motivation provision

Variable	Standardised coefficient	t	Significance
Teamwork	219	3 025	003*
Morale	177	1 700	090
Information Flow	027	292	770
Involvement	296	3 105	002*
Supervision	041	576	565
Meetings	- 228	-2 885	004*
Selection	- 044	- 600	549
Model Summary			
R	R Squared	Adjusted R Squared	Standard Error of the Estimate
483	233	216	8006

As is evident from table 9 52 three factors, those of Teamwork, Involvement, and Meetmgs, are identified as significant predictor variable for the organisational provision of Intrinsic/Internal Self-concept motivation The goodness-of-fit measure of 483 highlights the weaknesses of the relationships measured here Conceptual

explanation of this result is made difficult due to the integrated nature of the MMP factor Intrinsic/Internal Self-concept motivation provision

The next factor examined is that of Goal Internalization motivation provision Presented in table 9 53 is the regression model for the predictive ability of organisational characteristics on Goal Internalization motivation provision

Table 9 53 Regression coefficients and model summary for organisational characteristics of the OCS Revised and MMP factor Goal Internalization Motivation Provision

Variable	Standardised coefficient	t	Significance
Teamwork	- 076	-1 212	226
Morale	683	7 588	000*
Information Flow	028	358	721
Involvement	043	525	600
Supervision	- 056	- 920	358
Meetings	- 044	- 646	518
Selection	031	499	618
Model Summary			
R	R Squared	Adjusted R Squared	Standard Error of the Estimate
655	429	416	9301

Here we see only one OCS Revised factor identified as a significant predictor of this factor of motivational provision In this instance the organisational characteristic of Morale is most strongly related to the MMP factor of Goal Internalization motivation provision Though the goodness-of-fit for this regression model is higher than those previously presented it still represents a weak predictive model Suggesting alternative influences on the provision of Goal Internalization motivation

The relationship between organisational characteristics and the provision for Instrumental motivational needs are present next in table 9.54. One significant relationship was found between the provision for instrumental motivation and the organisational characteristics measured in the current study. A fact further emphasised by the poor goodness-of-fit, of .275, reported for this regression model. However this is not an unexpected result as few of the factors measured by the OCS Revised address any organisational aspects relating to the financial circumstances of organisational members that might be associated with the provision for instrumental needs. In this instance the OCS concept of Morale relates to the relationship between management and employees. For example issues of respect for employees, fair treatment, and motivation to perform are contained within this factor. It is likely that where individuals do not perceive equity in their salary and pay, or feel they are not being fairly rewarded for the work that they do, then they are also likely to report lower levels of morale, or satisfaction with the employer-employee relationship.

Table 9.54 Regression coefficients and model summary for organisational characteristics of the OCS Revised and MMP factor Instrumental Motivation Provision

Variable	Standardised coefficient	t	Significance
Teamwork	.022	.278	.781
Morale	.301	2.627	.009*
Information Flow	-.021	-.208	.836
Involvement	-.177	-1.697	.091
Supervision	.077	.995	.321
Meetings	.046	.528	.598
Selection	.012	.153	.878□
Model Summary			
R	R Squared	Adjusted R Squared	Standard Error of the Estimate
.275	.076	.055	1.3688

Presented in table 9 55 is the regression model for the relationship between organisational characteristics and the provision for External Self-concept motivation This analysis identifies several organisational factors that have predictive significance on the MMP factor of External Self-Concept motivational provision These factors include Teamwork, Involvement, and Supervision These identified relationships are intuitively related as they all pertain to the quality of the scientists' interactions with colleagues and superiors, which would be of integral importance in adequately providing for External Self-concept motivational needs Once again the goodness-of-fit for this regression model is weak, suggesting that alternative factors, not measured here may also play a significant part in influencing the provision for this motivational need

Table 9 55 Regression coefficients and model summary for organisational characteristics of the OCS Revised and MMP factor External Self-concept Motivation Provision

Variable	Standardised coefficient	t	Significance
Teamwork	475	7 717	000*
Morale	- 055	- 621	535
Information Flow	009	118	906
Involvement	255	3 149	002*
Supervision	204	3 415	001*
Meetings	- 059	- 878	381
Selection	- 062	-1 009	314
Model Summary			
R	R Squared	Adjusted R Squared	Standard Error of the Estimate
668	446	434	7234

In conclusion, hypothesis 2 states that 'The measurement of organisational characteristics of the research environment employed in the current study will relate directly to the measures of scientists experience of the organisations provision for

motivational sources' Three of the four MMP factors measured in the current study were found to be significantly related to organisational characteristics measured by the OCS Revised This finding supports hypothesis two Specific organisational characteristics have been identified as relating directly to the provision of the motivational needs measured m the MMP However the relationships identified here are weak This may partly be due to the limited number of organisational characteristics measured in the current study and suggests that considerably more research needs to be conducted before any definitive explanation can be made as to the relationship between organisational characteristics and the provision of motivational needs

9 9 The interaction between Motivational Sources and Motivational Provisions

The final hypothesis derived from the model developed during the course of the study states that 'The degree of fit between the scientist's experience of the motivational provisions of the research organisation and the scientist's motivational sources influences scientific effectiveness'

Testing this hypothesis requires a measure for each of the motivational sources contained within Leonard et al's (1999) meta-theory of motivation and a corresponding measure of the organisations provision for that motivational source

As mentioned previously in this chapter and discussed in chapter eight several weaknesses in both the MMS and the MMP have been identified For example six

factors were identified from a factor analysis of MMS items developed during the course of this research, but only five of these are identifiable in the meta-theory of motivation The additional factor identified, Achievement Need motivation does not have a corresponding measure of motivational provision, and consequently the interaction between this source of motivation and the provision for this source of motivation cannot be examined In addition to this the statistical reliability of some of the factors measured by the MMS are below the acceptable level of 0 7

Added to this is the fact that only four factors were identified during the factor analysis of MMP items in chapter eight The Intrinsic/Internal Self-concept motivational provision factor is an integrated factor comprising items originally developed to measure two separate constructs and consequently has no corresponding measure in the MMS

Results presented earlier in this chapter and displayed in figure 9 18 suggest that the top three motivators for most scientists are some combination of Achievement Need Motivation, Internal Self-concept motivation, and either Intrinsic Motivation or Goal Internalization Motivation Unfortunately measures for matching motivational provisions for most of these factors do not exist, and where they do, the sample of scientists who identify the motivational source as a primary source is so small as to offer little insight into the relationship Consequently the weaknesses identified in the measurement instruments developed during the current study preclude any suitable testing of hypothesis three

9 10 Conclusion

In conclusion results presented in chapter nine reflect the degree to which the primary research goals of the current study have been met and hypotheses have been tested Unfortunately not all goals have been met, to a satisfactory degree and consequently only limited conclusions can be made with regard to the model of research effectiveness put forward in the current study However the findings presented here do add to the literature on both the organisation of scientific effectiveness and work motivation, and their relation to this literature as well as the limitations of the current study and recommendations for future research are discussed more thoroughly in chapter ten

CHAPTER TEN

DISCUSSION, CRITICAL REVIEW AND RECOMMENDATIONS FOR FUTURE RESEARCH

10 1 Introduction

The initial goal of this study was to contribute to theory building on the role of the organisation in scientific effectiveness We started with an examination of the human and financial scale of scientific research in order to highlight the importance of science to society This was followed by a review of research approaches and topics from sociological, historical and psychological researchers, which highlighted the historical research focus on investigations into the factors that influence and predict scientific performance Research on the organisation of science and existing models of scientific effectiveness were then presented This was followed by an examination of the role of work motivation in the scientific endeavour and a review of classic and contemporary literature on work motivation The literature reviewed was then integrated and presented as a new hypothetical model of scientific effectiveness incorporating existing research on the organisation of science and work motivation In the current chapter we review the aim and theoretical framework of the current study We draw conclusions with respect to the influence and role of both the organisational environment and the scientist's motives to engage in scientific research In addition we review the adequacy of the hypothesised model Subsequently we discuss the limitations of the current study, with regard to the sample, the measures used and the

model itself, and make recommendations for future research This chapter then ends with a discussion of the practical implications of the study

10 2 Review of the aim and theoretical framework of the current study

The decision to study the nature of scientific effectiveness within research organisations resulted from a popular interest and background in the physical sciences coupled with a professional interest in organisational theory and the influence of the organisation on human performance More specifically the importance of the organisation in understanding scientific effectiveness and research performance has been highlighted in recent times by researchers such as Hurley (1997), Chawla and Singh (1998), and Mouly and Sankaran (1998) This research reflects a rejuvenation of interest in this topic, while also highlighting the lack of theoretical study that has focused on explaining, predicting and influencing scientific effectiveness

The model of scientific effectiveness developed during the course of the current study integrated existing research on aspects of scientific performance, creativity in science and work motivation so as to improve our understanding of the role and importance of both the characteristics of the organisation, and characteristics of the individual in determining levels of research performance The study offered a model that explained scientific effectiveness through the suitable interaction of organisational characteristics and appropriate motivational sources of the scientist It posed three main questions The first question was concerned with the nature of the relationship between the characteristics of the research organisation and its scientific performance The second question was concerned with the relationship between the characteristics

of the research organisation and scientists' experiences of how the organisation provided for their motivational needs Finally the third question was concerned with how the interaction between the scientists' motivational needs and the motivational provisions of the organisation influenced scientific effectiveness In order to answer these questions we formulated three hypotheses and conducted an investigative survey based study with a sample of scientific researchers working in UK universities Instruments were developed to measure the variables contained within the hypothesised model The data collected from the 330 participating scientists was then statistically analysed to determine the validity of the model and to test the hypotheses derived from it

10 3 The organisation and scientific effectiveness

One of the primary goals of the current study was to examine the nature of the relationship between the organisation and scientific effectiveness The importance of the organisation as an influential factor in explaining scientific effectiveness has been identified in the literature by such researchers as Argyris (1968), Unesco (1979), Glueck and Thorp (1971), Hurley (1997) and others However the nature of this relationship was for from clear Hypothesised models were either lacking empirical support such as Hurley (1997) and Thamhain and Wilemon (1987) or examined relationships from a linear perspective, that is they examined if linear improvement in characteristics of the research organisation corresponded with linear improvements in scientific effectiveness

The current study operationalised the concept of the organisation using Glaser et al's (1987) Organisational Culture Survey, with additional items from Conway (2003) This measurement instrument was found to be reliable, with the exception of the factor Selection, whose scale reliability was slightly below the acceptable standards of measurement instruments utilised for research purposes

Initial analysis of the data took a linear approach In doing so it identified only one significant linear relationship, that of Morale Although the identification of this relationship was significant the strength of the relationship was weak (r = 26) The relative weakness of this result was not entirely surprising in light of studies that have examined the link between organisational characteristics and research effectiveness from similar perspectives, such as Unesco (1979) An alternative approach was then taken in the analysis of the data An analysis of the variation in organisational characteristics across RAE performance categories was conducted This allowed for the investigation of differences between groups to determine if any difference existed in their organisational characteristics and if so where this difference lay

The results presented a clear pattern Many of the organisational characteristics of participating departments in RAE performance category three were found to be significantly lower than the higher RAE performance category participants This was true for the organisational characteristics of Morale, Information Flow, Supervision, Meetings, and Involvement In the case of the factor Involvement both RAE department categories two and three were found to have significantly lower scores than the higher ranked RAE departments In addition the statistically unreliable measure of Selection was found to be significantly lower for category three RAE

ranked departments than category four and five departments The explanation of these findings is complicated by the fact that RAE category two departments were not found to have significantly lower scores on most of the afore mentioned organisational characteristics than the higher RAE performance category participants However, as mentioned in chapter nine the number of responses that comprise the results for category two departments was much smaller than for other response categories In fact the data collected from category two respondents represented only 21 individual respondents from two participating departments This brings into question the representative nature of these responses

If we disregard RAE category two responses due to their small size, the potential significance of the results on the organisation of science is more clearly identifiable Differences in the organisational characteristics of Morale, Information Flow, Supervision, Meetings, Involvement, and the statistically unreliable measure of Selection can distinguish RAE category three departments from higher ranked departments, but differences across these variables are not sufficient to distinguish categories four, five and six from each other Such findings are in line with other research studies on the link between the organisation and scientific research effectiveness

For example Argyris' (1968) analysis of organisational factors that influence the effectiveness of research and development organisations highlighted several organisational factors that could inhibit or promote performance This research did not suggest a linear relationship between organisational characteristics and performance, but rather stated that specific organisational characteristics should be in place and

operating effectively in order for the organisation to be productive The findings of the current study provide empirical support Argyris' claims By identifying a 'minimum' operational level of several organisational characteristics necessary for effective research to take place, the current study adds weight to Argyris' argument that ineffective management and inappropriate organisational circumstances will inhibit research performance

Similar concepts are contained within Thamhain and Wilemon's (1987) systems model of research effectiveness Thamhain and Wilemon identify influencing factors of the organisational environment under the two headings of drivers and barriers Barriers inhibit effectiveness, while drivers promote effectiveness Results from the current study suggest that single factors can act as either drivers or barriers depending on their relative position on a positive to negative continuum This is a reasonable proposition and is suggest in the work of Hurley (1997) and Mouly and Sankaran (1998) Essentially a single organisational characteristic, say teamwork, can act as a driver or a barrier depending on whether team functioning is manifested in a positive, efficient, constructive manner (driver) or is manifested in a dysfunctional, ineffective, and destructive manner (barrier) By viewing results from the current study from the perspective of Thamhain and Wilemon's (1987) systems theory, we might suggest that the factors of Morale, Information Flow, Supervision, Meetings, Involvement, Selection are so low as to be barriers to effective research in our category three RAE departments, but are of sufficiently high levels to be drivers for our category four, five and six RAE departments

The current findings can also be used to provide greater explanation and empirical support to Mouly and Sankaran' s (1998) ethnographic study of a dysfunctional research unit In light of findings from the current study it is likely that the organisational characteristics of the research unit examined by Mouly and Sankaran were significantly lower than the characteristics of Morale, Information Flow, Supervision, Meetings, Involvement, and Selection for the RAE level four, five, and six departments that participated in the current study

The current study also offers insight into the essentially descriptive findings presented in reviews of the organisation and management of science by researchers such as Glueck and Thorp (1971) and Bland and Ruffin (1992) Findings from the current study support earlier claims as to the importance of organisational characteristics in the research environment, but also elaborate on such findings by identifying the probable nature of the relationship between characteristics of the research environment and scientific effectiveness

The results of the current study also offer an elaboration on Baumgartels (1956) work Baumgartel essentially identified a relationship between leadership styles and the degree of motivation and satisfaction of scientists in research organisations These characteristics were used as a proxy for performance The current study clearly identifies the OCS factor of Supervision as significant in the relationship between organisational characteristics and scientific effectiveness Though Baumgartels concepts of leadership were linked to a specific leadership theory, there is distinct conceptual similarity between the concepts of leadership and the concept of supervision Through the juxtaposition of the these findings we can suggest, with

some empirical support that the link between supervision, motivation, and an outcome measure of research effectiveness should be identifiable, and that the current findings offer support for the general premise of Baumgartel's (1956) study, that leadership styles affect research performance

Results from the current study suggest that an alternative explanation must exist for the variation in performance levels between the higher RAE ranked departments (i e category four, five and six departments) Results suggest that a minimum level of the organisational characteristics examined in the current study must exist in order to facilitate a moderate level of scientific effectiveness, but that these characteristics are not sufficient in distinguishing between higher levels of research performance

Such findings lend support to Hurley's (1997) proposition that it is the suitable combination of both organisational characteristics and individual characteristics that leads to scientific discovery In the current study we have demonstrated that specific levels of organisational characteristics seem necessary in order to attain a level of research performance but are not sufficient in determining variation in performance at more advanced levels This variation at the higher end of the performance spectrum might then be accounted for by variation in the skills, knowledge, and ability of the individual members of the organisation This result also suggests that the impact of the organisations characteristics on scientific effectiveness is not a linear one The improvement of the organisational environment in which scientific research takes place will only lead to improved research performance to a point Once the organisation has reached this point it is alternative variables, possibly the individual

characteristics of the organisations members, as suggested by Hurley (1997), which may determine the degree of research effectiveness

Perhaps the most significant contribution of the results of the current study relating to the influence of organisational characteristics on scientific effectiveness is their ability to offer greater elaboration and explanation of the findings of the Unesco (1979) study

The Unesco (1979) study is the largest, most elaborate, and complex, study of its kind Great detail and attention was given to the design and implementation of the study and the statistical procedures employed were well conducted and robust Despite these characteristics of the study, it found only weak to moderate links between characteristics of the research environment and research productivity The current study informs the Unesco findings by suggesting that the relationships identified were in fact not weak, but considerable and significant A possible flaw in the Unesco study centres on the linear approach to data analysis that was employed in the study The current study, using ANOVA, identifies difference across groups by performance levels, but also provides evidence that these differences and the factors that might influence these differences do not follow a linear relationship The author suggests that a re-evaluation of the Unesco data employing non-linear analysis such as ANOVA may yield further interesting and important results

10 4 The organization and motivational provisions

A key aspect of the model of scientific effectiveness developed during the course of the current study was the hypothesised link between the characteristics of the research organisation and the scientists' experience of how well their motivational needs were provided for by their work environment Research on the link between organisational characteristics and motivational provisions was exploratory in nature as no *a priori* links were drawn between specific organisational characteristics and specific motivational provisions

The first motivational provision examined in the results was that of Intrinsic/Internal Self-concept motivational provision The link between this factor and the factors of the OCS Revised was conducted using regression analysis In total three organisational characteristics were found to be related to scientists experience of their provision for this motivational sources The organisation characteristics in question are Teamwork, Involvement and Meetings Conceptual explanation of these relationships is complicated by the fact that the factor Intrinsic/Internal Self-concept is an integrated concept not clearly identified in Leonard et al's (1999) meta-theory of motivation, as reported in chapter eight It is possible that provisions for the two separate motivational sources of Intrinsic process motivation and Internal Self-concept motivation are so integrally linked in the current participant sample that the items of these factors were identified as statistically congruent However this cannot be confirmed, as no data exists for responses to the items of the MMP for other populations Consequently discussion of this factor and its relation to the OCS Revised factors incorporates the conceptual meaning of both the Intrinsic process

factor and the Internal Self-concept factor In essence we see the combination of enjoyment in the task itself as related to Intrinsic process motivation with the sense of personal satisfaction in realising potential and personal achievement as related to Internal Self-concept motivation Essentially we see the organisations ability to provide a work environment where individuals enjoy the work that they do, and gain satisfaction from their achievements and the ability to real their potential, as integrally linked

As mentioned previously the three OCS Revised factors found to relate to the MMP factor of Intrinsic/Internal Self-concept motivational provision are Teamwork, Involvement and Meetings This suggests that the organisations ability to provide for the motivational needs of Intrinsic process motivation and Internal Self-concept motivation is dependent on the positive interaction of team members, including cooperation, constructive criticism, positive conflict resolution, and concern for others It is also related to the degree of involvement that organisation members have in decision making, the feeling that their ideas and suggestions are valued and that their opinions count Finally it is also related to constructive meetings, where discussion is open and outcomes are acted upon Though this finding is significant the poor fit of the linear regression model suggests that there are other organisational variables that may influence the organisations ability to provide for Intrinsic process and Internal Self-concept motivation This issue is also addressed during the discussion of the limitations of the current study

The MMP factor of Goal Internalization motivational provision was found to be related to only one OCS Revised factor, that of Morale The provision for Goal

Internalization refers to the degree to which the organisations goals are consistent with the individual's goals Findings of the current study suggest that the organisations ability to provide for this motivational source is related to the fair and consistent treatment of its employees, trust and respect of employees, and a sense of belonging Again the degree of fit of the linear regression model is quite poor, suggesting that alternative organisational characteristics, not measured here, are also important in determining the organisations ability to provide for this need An analysis of variance for MMP factors across RAE ranked departments distinguished RAE category three departments as having lower levels of Goal Internalization provision than the higher ranked level four, five and six departments Despite the identification of only one organisational characteristic related to this concept, this finding does suggest that the organisational provision for Goal Internalization motivation is important in the context of scientific effectiveness

In the case of External Self-concept motivation provision, three factors of the OCS Revised were found to influence the organisations ability to provide for this need These were Teamwork, Involvement and Supervision The External Self-concept motivational provision relates to the organisations ability to provide for the scientists need for positive interaction, recognition, and approval from others m the organisation Clearly organisational characteristics such as positive team working, involvement in decision-making and constructive and supportive supervision are all related to this concept The identification of these relationships supports the hypothesis that organisational characteristics are related to the scientist's experience of the degree to which their host organisation provides for their motivational needs Specifically the link between this motivational provision and the OCS factor of

Supervision is important as they are conceptually related to and offer empirical support of Baumgartel' s (1956) study on the link between leadership styles and motivation

The final MMP factor of Instrumental motivational provision was found to be related to only one of the OCS Revised factors This is a significant finding as few of the OCS Revised factors pertained to the instrumental aspects of salary, or remuneration The only relationship identified was between the OCS factor of Morale and Instrumental motivation provision This relationship is likely to exist due to the nature of items contained within the OCS factor of Morale Many of the items within the factor Morale relate to the relationship between management and employees, the degree to which employees feel they are treated fairly, respected and motivated by the organisation to perform It is likely then that we would expect to find a relationship between the degree to which individuals feel they are treated fairly by their employer and the organisations provision for their instrumental needs The lack of other identifiable relationships between factors contributes to the validity of the measurement instruments Although no *a priori* relationships were suggested before analysis took place, an examination of the content of factors OCS suggests that there would be no intuitive relationship between the provision for Instrumental motivation and any of the other organisational characteristics measured in the current study The lack of identifiable links between these factors lends some support to the conceptual validity of both the OCS Revised and the MMP

To conclude this section, the identification of direct relationships between organisational characteristics and the organisations ability to provide for its

employees sources of motivation is significant not only to the current study, but also to literature on work motivation This finding highlights the influence of the organisation on the individual and adds to the literature on the role of the organisation in affecting scientist's motivation and performance Though the primary motivational theory utilised in the current study was Leonard et al's meta-theory of motivation it is not surprising that we see conceptual similarities between the findings of the current study and classical motivational theory, considering the integrated nature of the meta-theory put forward by Leonard et al (1999) For example the relationship between OCS Revised factors and other MMP factors can be linked respectively with the equivalent concepts of 'core job characteristics' and 'critical psychological states' as presented in Hackman and Oldham's (1976) job characteristics theory The link between organisational characteristics and motivational provisions is clearly identified in the current study Equating the organisational characteristics of the current study with 'core job characteristics' and motivational provisions with 'critical psychological states' allows for alternative interpretation of results and also highlights some very interesting avenues for future research An alternative theoretical explanation of the results could also be taken by viewing them from the perspective of Hertzberg's (1968) dual factor theory of motivation Given the nature of the relationship between the organisational characteristics and scientific effectiveness identified in the current study, it can be suggested that what has been identified here are a number of hygiene factors that are necessary for organisational performance at a moderate level, but are not sufficient to motivate scientists to higher levels of performance

The identification of the existence of theoretical overlap between the findings of the current study and classical motivational literature is significant Specifically, it

reaffirms the need for greater study on the influence of motivation on scientific research, but more generally it highlights the potential insight that could be gained by applying organisational behaviour theory to the topic of scientific effectiveness

10 5 Scientists motivational profile

A primary research goal of the current study was the construction of a motivational profile of scientists This was necessary in order to examine the relationship between the motivational provisions of the organisation and the motivational needs of the scientist and how this relationship affected scientific effectiveness Unfortunately this goal was hampered by the poor reliability of instruments used to measure these factors In the case of measuring motivational sources six factors were identified, one more than the original five intended during the construction of the MMS However this, in itself, is a significant finding as it pertains to Leonard et al's meta-theory of motivation

The additional factor identified was labelled Achievement Need motivation due to the conceptual similarity of the items that make up the factor with McClelland's (1961) concept of Achievement Need The factor identified in the current study had low scale reliability Consequently no definitive conclusions can be drawn from its identification However its identification does suggest that a review of the motivational concepts in Leonard et al's meta-theory may be necessary In particular the concept of Internal Self-concept motivation As discussed in chapter eight, the identification of Achievement Need as a separate factor came about as a result of the poor fit of some items intended to measure the concept of Internal Self-concept

motivation A further analysis of the description of this concept within Leonard et al's meta-theory of motivation alluded to the dual nature to this concept

'The individual tends to use fixed rather than ordinal standards of self-measurement as he/she attempts to first reinforce perceptions of competency, and later achieve higher levels of competency This need for achieving higher levels of competency is similar to what McClelland (McClelland, 1961) refers to as a high need for achievement " Leonard et al (1999) p 984

The first aspect of this concept is the reinforcement of the individual's perceptions of competency, by repeatedly meeting their own standards of behaviour and performance, while the second aspect, the later achievement of higher levels of competency, sees the individual strive for greater levels of achievement based on their personal standards Although Leonard et al's theory is an attempt at the integration of many motivational concepts, results from the current study suggest that the place of the Achievement Need within the theory may require some re-evaluation

Other significant findings arose from the examination of the profile of scientists' motivations Although the poor reliability of the measurement scales of the MMS precludes any definitive conclusions being drawn, findings do highlight an interesting pattern in scientist's motivations The profile of motivational sources for all participating scientists shows scientists to have rather 'self' focused sources of motivation For example the top two highest mean scores across the six motivational sources were for Achievement Need, and Internal Self-concept motivation These

were followed by Goal Internalization and Intrinsic process motivation, followed lastly by External Self-concept motivation and Instrumental Motivation Here we see the scientists predominantly concerned with personal achievement, the realisation of personal beliefs, standards and values, the need to relate to and believe in the goals they are working towards, and the need to gain enjoyment from the tasks they must engage in during the course of their work, these are followed by the lesser motivational concern for positive peer evaluation, and a much less concern for instrumental motivation

Although this finding should be viewed cautiously, it relates to existing research on the personality of scientists Feist and Gorman (1998) summarised the personality characteristics of scientists as achievement orientated, conscientious, dominant, driven, emotionally stable, impulse controlled, independent, and introverted We can see how many of these personality characteristics relate to the self-focused nature of scientists motivational sources Results suggests that a more detailed examination of the link between the scientific personality and scientists motivations may be warranted and could provide us with a greater understanding of the factors affecting scientific effectiveness The similarity between the personality characteristics identified in the literature and the motivational sources identified here, also adds some validity to the scientists motivational profile identified during the course of the current study

An additional finding of possible significance is the identification of the External Self-concept as a relatively weak motivator in comparison to factors such as Achievement Need and Internal Self-concept It may be that the motivational profile

identified in the current study is important in determining scientific effectiveness, though due to poor measurement instruments, its importance cannot be confirmed by this study For a moment let us presume from a hypothetical perspective, that the motivational profile identified here is accurate With this in mind let us also consider the modern focus on scientific evaluation The frequency of the evaluation of scientist's research has already been mentioned in this study and the reality of this fact of modern science was utilised in the construction of the SERPP used in this study In light of the current findings on the motivational profile of scientists, this often frequent and repeated evaluation of research may have detrimental effects on the quality of future scientific research Continuing and indeed increasing focus on the evaluation of scientific research may force scientists to become more concerned and motivated by peer appraisal and collegial evaluation, and potentially less motivated by Achievement or Internal Self-concept motivation, which in turn may affect scientific performance Though this is only a hypothesised consequence of the limited findings from the current study it is worthy of note and of future research It is important that research on the possible influence of persistent evaluation of scientific research takes place, so as to identify and possibly offset any negative consequences of such evaluations

Another interesting finding on the variation of motivational sources across scientists of varying levels of ability was the significant difference between the levels of Internal Self-concept motivation for SERPP level one scientists and SERPP level four and five scientists It seems that level one scientists were not as motivated by the need to meet personal standards and gain personal achievements It was also found that SERPP level one scientists were significantly more motivated by Instrumental

motivation than their colleagues at level two, three, four and five This finding may result from the relatively young age demographic of the SERPP level one participants It is more likely that many of the younger participants would be more concerned with instrumental issues due to their relatively low salaries, and lack of tenured security, while they may also not be in a position to realise personal standards and achievements due to their relative inexperience

A final issue of note relating to the motivational profile of scientists is the role of intrinsic motivation Research by Amabile (1983) on creativity m science proposes that intrinsic motivation plays a key role in influencing creativity Amabile also suggests that creativity is a key component of scientific effectiveness, and that the ability of the scientist to be creative is influenced significantly by their level of intrinsic motivation If we accept this argument as true then we would expect to find variation in the levels of intrinsic motivation across scientists with differing levels of performance If scientific effectiveness is dependent on creativity and creativity is strongly influenced by intrinsic motivation, then we would expect to see a variation in research performance with any variation m intrinsic motivation However, no significant difference exists in the current data between the levels of intrinsic motivation of scientists across different SERPP levels This finding suggests a need to re-examine the validity of Amabile's Componential Model of Creativity The results from the current study suggest that either the link between creativity and scientific effectiveness is not as direct as Amabile (1994) would have us believe, or the role of Intrinsic motivation in influencing scientific creativity is not of such central significance as suggested in the Componential Model of Creativity (1983) While the significance of these results to Amabile's Componential Model of Creativity is

interesting they should be viewed with extreme caution due to the poor reliability of the scale used to measure Intrinsic motivation However as there is limited empirical data on the link between creativity and scientific effectiveness, the current findings highlight a need for a more thorough investigation of the Componential Model of Creativity and its relevance to scientific effectiveness

10 6 Adequacy of the current model

The model presented in the current study offers a hypothetical description of the relationship between the organisation, scientists motivations, and scientific effectiveness In the case of the direct link between the characteristics of the organisation and scientific effectiveness the model is useful, and results inform existing literature on the organisation of scientific effectiveness, suggesting that suitable organisational characteristics are necessary but not sufficient in explaining scientific effectiveness These findings offer empirical support and theoretical elaboration on existing literature on this topic The model also depicts the link between the characteristics of the research organisation and the experienced levels of motivational provision for scientists, which is partially confirmed by the results Key conceptually sound relationships were identified between organisational characteristics and motivational provisions Unfortunately no support exists for the interaction of organisational provisions and motivational sources and the hypothesised effect of this interaction on scientific effectiveness However this lack of support does not undermine the validity of the current model, as it is based on an inability to adequately test the hypothesis relating to this interaction rather than on results that contradict the relationships contained within the model Consequently the current

model still exists as a reasonable, hypothetical explanation of scientific effectiveness with existing results supporting some aspects of the model, namely the relationship between organisational characteristics and scientific effectiveness, and the relationship between organisational characteristics and scientists experience of their motivational provisions, with insufficient data to test the effect that the relationship between motivational sources and provisions may have on scientific effectiveness

10 7 Limitations and recommendations for future research

The following sections describe the limitations of the current study and make recommendations for future research The practical implications of the current study are also discussed

An obvious outcome of the analyses presented in chapters eight and nine is the identification of weaknesses in the measurement instruments used in the current study These weaknesses were both statistical and conceptual in nature In the case of the MMP we found that while the statistical reliability of the scales were good the conceptual validity of one of the scales was questionable As the factors of the MMP were designed around the factors contained within Leonard et al (1999) meta-theory of motivation it was expected that the factors identified from the factor analysis of MMP data in the current study, would correspond to those of the meta-theory However the factor analysis of MMP data yielded an unexpected factor in the form of the Intrinsic/Internal Self-concept motivational provision This factor was labelled such to reflect the integrated nature of the original factor items There are several possible explanations for the appearance of this factor in the current study

One explanation is that the original items of the MMP designed to measure these factors did in fact measure two unique concepts of motivational provisions, but that the relationship between these concepts in the participant sample were so related that the items were identified as one factor during statistical analysis This is a possible but unlikely explanation

Another possible explanation is that the separate concepts of Intrinsic motivational provision and Internal Self-concept motivation provision do not in fact exist, and that they are in fact one concept, as identified in the factor analysis of MMP data This is also a possible but highly unlikely explanation Especially when we consider that two unique factors for the Intrinsic motivational source and Internal Self-concept motivational source were identified in the factor analysis of the MMS If these concepts can be identified as unique sources of motivation then we should also be able to identify their provisions as unique factors

The final and most obvious and reasonable explanation is that there are innate weaknesses in the items that were developed for both the Intrinsic provision scale and the Internal Self-concept provision scale Results would suggest that there was not sufficient conceptual differentiation between the items used to measure both factors Consequently during the factor analysis of MMP data the majority of items from both original factors were identified as a single factor The author concedes to the principles of Ockham's razor and suggests that the most likely explanation for the inability of the MMP data to accurately distinguish the two factors of Intrinsic

motivational provision and Internal Self-concept motivational provision is due to weaknesses in the items of the relevant scales

In the case of measuring motivational sources one more factor was identified than the original five presented in Leonard et al's (1999) meta-theory of motivation Though the identification of this additional factor was unintentional, it is of significance to the meta-theory and suggests a need to re-evaluate the position of McClelland's Achievement Need within the theory The importance of this finding is tempered by the weak scale reliabilities for many of the scales of the MMS including the Achievement Need Scale The scales of Internal Self-concept motivation and Intrinsic motivation were also found to have unacceptably low reliabilities Though the scale reliabilities of the MMS were improvements on the MSI scales that they were designed to replace, they were still lacking in their ability to accurately measure the concepts of Leonard et al's (1999) meta-theory Again the likely cause of these weaknesses is poor item construction for the scales in question

Ideally it would have been more suitable to have both MMS and MMP developed, tested and validated more thoroughly prior to their use in the current study However due to the relative newness of the meta-theory of motivation incorporated in the current study, no suitable and reliable instruments existed at the beginning of the study Consequently new measures had to be developed This development took place within the temporal and financial constraints of the PhD process which contributed directly to the nature of the instrument development, and the compromises that were made as a result For example during the initial stages of scale testing a scale reliability analysis of items of the MMS and MMP was conduced, rather that the more

detailed and informative factors analysis It became clear at the early stages of the study that attaining participation from a sufficiently large sample of research active scientists would be a difficult task At the time of instrument development there was concern that the number of responses required to run a factor analysis would contaminate or exhaust a significant proportion of the available sample of potential participants whose responses would be more critically required in the main data collection phase of the study Consequently, the decision was made to pursue the issue of instrument development with care and diligence while also carefully limiting the participation of scientists The necessary but unfortunate consequence of this decision was that the final validation of instruments and analysis of results had to be conducted, essentially, in parallel, which contributed to the weaknesses in instruments developed for the current study

Every effort was made, during the course of instrument selection, to identify a measure of organisational characteristics that could encompass as many important variables identified in the literature as possible However it was simply not feasible to administer an exhaustive measure of organisational characteristics to the current studies participants An examination of the factors included in the OCS Revised (Teamwork, Morale, Involvement, Information Flow, Meetings, Supervision, and Selection) shows considerable conceptual overlap with the many organisational characteristics identified in the literature The scales used to measure these characteristics were also found to be statistically reliable, with the exception of the characteristic, Selection Despite these positive indications the limited number of organisational characteristics measured in the current study limits the explanatory power of the findings relating organisational characteristics to motivational

provisions As mentioned previously the linear regression analyses of OCS Revised factors with MMP factors, identified only a small number of relatively weak relationships, suggesting that there are alternative organisational concepts that influence scientists experience of their motivational provisions

Another readily identifiable limitation of the current study relates to the sample of participants who took part Firstly the sample size examined in the current study was limiting The difficulty with conducting research on scientists or any professional group is ensuring sufficient participation If we consider the normally heavy workload of scientists coupled with their personality characteristics, identified in the literature review, and their motivational profile identified here, then we can begin to understand the poor response rate to the questionnaire The likelihood of participation may also have been affected by the size of the questionnaire used in the current study Taking all measurement instruments together the questionnaire required participants to respond to a total of 112 individual items

Another important sampling issue is the relative homogeneity of the 'type' of scientists who participated Participation was only requested from scientists working in organisations that could be reasonably identified as 'knowledge seekers' according to Wilts' (2000) categorisation of research organisations As mentioned previously scientists from biological science and chemical science departments in UK universities were selected Consequently it is important that all results from the current study are not generalised beyond this sample Though some limited generalisations can be drawn from the current study, further examination of other scientific disciplines as well as scientists from different cultures, needs to be

conducted before we can truly begin to discuss the current findings as relating to 'scientists' as a whole. The issue of gender in the current study is also important. The majority of participants were male and this may have a significant bearing on results. As suggested by Cole (1987) some differences in performance may be related to the issue of gender. However the limited number of female participants in the current study did not warrant nor facilitate a specific examination of possible gender difference. This issue does not warrant excessive concern as existing research on gender differences in scientific performance suggests that any gender difference in performance is likely to be quite small (Long, 1992; Sonnert, 1995). As a result of the small number of female participants in the current study any generalisation of results should be limited to male scientists.

The research methodology employed in the current study was a reasonable one. Consideration of the nature of the concepts under investigation and the nature of the participants was taken during the design of the study. Ideally a repeated measures experimental design, allowing for the manipulation of organisational variables would allow for much stronger conclusions to be drawn about the causal link between the relationships presented in the theoretical framework. However such a methodology would be extremely difficult to employ, and even if resources did allow for such a design, ensuring participation from research active scientists would be problematic.

Considering the limitations presented above the practical implications of the current study for scientists and managers of scientific research are limited, but important. The link between the organisational environment and scientists' experience of their motivational provisions has been established in the current study and this finding

holds practical implications for those in a position to influence the environment of the research organisation Though the interrelation between these factors, the motivational profile of scientists and scientific effectiveness has not been confirmed here, it is still a credible hypothetical relationship, which should be at least considered in the context of the research organisation

Essentially there does seem to be a need for suitable organisational characteristics to exist in order for a moderate level of scientific research effectiveness to take place, and this finding is supported in the literature If scientists currently working in relatively unproductive research environments wish to improve productivity then attention must be paid to the organisational environment in which they work The current study is also of practical use in that it provides some baseline data for the organisational characteristics measured here Archiving data from the current study would allow concerned research managers to administer the OCS to their employees and compare results, giving them an indication of the relative suitability of their organisational environments to scientific effectiveness

In short, scientists seem to be motivated by the task of science, and the internal rewards of personal satisfaction and achievement that comes from the scientific endeavour Consequently science managers and administrators should look to their organisational environment to ensure that they are fostering a productive and facilitative work place that will allow researchers to reach their potential and maximise their scientific effectiveness

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APPENDIX A1: Questionnaire administered to ENWOP group

James C Ryan
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Dear Colleagues,

I am writing to request your assistance in an aspect of my current PhD research At present I am examining scientific research effectiveness from the perspective of the scientists motivational profile and the degree to which the research organisation provides for their motivational needs In doing so I am incorporating Leonard, Beauvis, and Scholl (1999) Meta-Theory of motivation into my research At present there exists one measurement instrument developed by Barbuto and Scholl (1998) in the USA, which reports to reliably measure the concepts of the 'meta-theory' of motivation Having analysed responses to this instrument from several hundred Irish participants I have not found reliabilities of sufficient strength for my future study and consequently have to develop my own instrument It is in this regard that I hope you can help

In order to measure these concepts I wish to develop a paper and pencil measurement instrument whereby participants will respond to a series of statements related to each of the five motivational concepts of the theory To do this validly and reliably I require statements that can be reasonably and logically related to each of the five concepts defined in propositions 6,7,8,9, and 10 of the meta-theory

What I request from you, is that you indicate in the space provided what you believe to be the meaning of the statements What is your understanding of them within the context of the work environment? What words or phrases do you think might be conceptually related to them? This information will then be used to assist me in the development of a suitable measurement instrument, which will aid in my progression towards my PhD

P6. When faced with alternative tasks, individuals dominated by *intrinsic process motivation* will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable.

P7 When faced with alternative tasks, individuals dominated by *instrumental motivation* will engage in the task that provides the greatest potential for extrinsic rewards, and the behaviour will be sustained as long as the likelihood of attaining those rewards remains

P8 When faced with alternative tasks, individuals dominated by *external self-concept based motivation* will engage in tasks that provide them with affirmative social feedback relative to others, concerning their traits, competencies, and values in their important identities Behaviour will be sustained as long as relative, positive social feedback is forthcoming

P9 When faced with alternative tasks, individuals dominated by *internal self concept based motivation* will engage in tasks that provide them with affirmative task feedback about their traits, competencies and values in their important identities Behaviour will be sustained as long as positive task feedback is forthcoming

P10 When faced with alternative tasks, individuals dominated by *goal-Internalization motivation* will choose to engage in tasks that have the greatest potential of achieving the groups or organisations goals Behaviour will be sustained as long as progress towards those goals continues

I would like to take this opportunity to thank you for your time and efforts and assure you that the information you have provided will greatly assist me in my research If you would like any further information about my work or have any questions or comments you would like to address with me directly, please feel free to contact me at the address given at the start of this letter

Sincerest thanks,
James Ryan

APPENDIX A2: Responses to ENWOP questionnaire

P6 When faced with alternative tasks, individuals dominated by *intrinsic process motivation* will choose the task which is more enjoyable and the behaviour will be sustained until the task is no longer enjoyable

Candidate 1

Ok! I think so Individuals will choose tasks that are more enjoyable They are tasks that provide happiness, satisfaction, because through doing them individuals grow their competencies, self-efficacy and self-esteem

Usually I enjoy my work

I feel I am growing when I am doing my work

I'm happy doing my work

My work permits me to grow personally and professionally

I love my work although it has low remuneration

Candidate 2

This person likes challenging and enriched work She does not think of money when doing the job She is doing the job because she like the content Job related committed to job realisation Autonomous from external pressures (Social)

Candidate 3

Task is motivating in itself- no need for reinforcements

Hedonistic view of motivation

Motivation is a function of the here and now

Motivation may be achieved by engineering the task

Candidate 4

Setting self-directed goals The task has a challenging appeal Working on it gives me Self-worth I realise my best possibilities Figuring things out is very intriguing
Making a contribution of social value
Making a contribution of aesthetic value

Candidate 5

Intrinsic process motivation tackles the interest and joy of people So people feel motivated to choose those tasks that are more interesting and better fit their

preferences Further people prefer to have control on the start the task performance as well as the moment when they want to finish it

Candidate 6

Flow engagement persistence and challenge

Candidate 7

For me, the job is good I need to feel involved
I have only applied for jobs that give me pleasure and enjoyment

I would accept a lower salary for a job that I really enjoy

I would not stay in a job that offers no or little fun and pleasure in the everyday work

P7 When faced with alternative tasks, individuals dominated by *instrumental motivation* will engage in the task that provides the greatest potential for extrinsic rewards, and the behaviour will be sustained as long as the likelihood of attaining those rewards remains

Candidate 1

Yes they will engage in the task that provides the greatest potential for extrinsic reward, and so, their intensity is smaller than in case of doing tasks dominated by intrinsic motivation
But motivation is strength of behaviour So that is really behaviour motivated because individuals begin and sustain a behaviour with some strength

Usually I do my work because I want to reach a good salary
My work is boring but I do it because I need to eat
My work is not very interesting but is stable and safe

Candidate 2

Opposite to proposition 6 Prefers monetary reward before anything else Also other rewards like career possibility, individual benefits When she must decide between interesting job with low pay and dull job with high pay she selects the latter
Externally guided, field dependent, performance orientated

Candidate 3

Motivation is a function of goals
Motivation can be achieved by engineering goals and expectations
Pragmatic view of motivation
Economic man

Utilitarianism
What's in it for me – this situation?

Candidate 4

It gives me prestige/recognition
It gives me access to career opportunities
I can acquire influence working it
It gives me financial resources
I can get what I want later doing this research is a step to further projects

Candidate 5

People perform several tasks because of its instrumental value to achieve valued outcomes Instrumentality or contingent relation of a task with valued outcome is a relevant property of a task and is a motivational cue for individuals that are interested in achieving certain valued outcomes

Candidate 6

Calculative
Economic
Effort management/control
Expectancy

Candidate 7

An interesting job cannot compensate for a poor salary
Apart from giving me resources for all kinds of activities and purchases, a high salary makes me feel good

P8 When faced with alternative tasks, individuals dominated by *external self-concept based motivation* will engage in tasks that provide them with affirmative social feedback relative to others, concerning their traits, competencies, and values in their important identities Behaviour will be sustained as long as relative, positive social feedback is forthcoming

Candidate 1

Ok! I think so I agree, and I think that behaviour is sustained as long as positive social feedback is forthcoming So behaviour is probably shorter and less strong than internal behaviour, dominated by internal self-concept based motivation

What I want more easier in my work is that my boss recognises me as a good employee

I understand people who work intensively to reach the title of 'the best salesman' similarly in their business

The recognition of my boss is the most important reward that I can reach in my work

I enjoy very much that my colleagues believe that I am a very good professional

Candidate 2

Dependent on others, externally oriented, extrovert field dependent, non-autonomous, not able to make decisions by himself, unsure, strive for attention performance emphasis

Candidate 3

Social Man

Reinforcements to be found in the social context

The Clan as a source for motivation
Some people exist through their groups

Candidate 4

Belonging to groups of significant others Get respect from superior Get appreciation from colleagues and friends
Get peoples attention
Get promotion and recognition
Feel reinforced in the best of my abilities

Candidate 5

Positive feedback from other is a very positive cue to help people motivated by external self-concept So as far as certain tasks provide opportunities to receive social information about the others perception of oneself, individually motivated by external self concept will experience desire of performing such a task

Candidate 6

Information

Social approval
Search for feedback
Social sensitivity

Candidate 7

My best reward at work is the appreciation of my clients/patients/pupils

I like manager who tell you when you perform well

Encouraging comments from colleagues will make my day

P9 When faced with alternative tasks, individuals dominated by *internal self concept based motivation* will engage in tasks that provide them with affirmative task feedback about their traits, competencies and values in their important identities Behaviour will be sustained as long as positive task feedback is forthcoming

Candidate 1

'Intrinsic motivation' is perhaps , more related to task, to kinds of tasks, and internal motivations related to individuals, their values, desires, aims, etc,

My work has a very big satisfaction for me

My work gives me more than several rewards It is the sense of my life

Through my work I can to reach aims that make sense in my life

I love my work because it permits me to be that I always wanted to be

Candidate 2

Introverted, internally oriented, individualistic, internal growth, own values, own rules, autonomous, able to make decisions

Candidate 3

Inner Standards of behaviour
I know what I want from myself
It is important for me to be perceived according to my own standards

Candidate 4

Live up to my aspirations
Feel that I can develop my capabilities
Can live up to my ideals
Give me the feeling of self-realisation
Give me the chance to give the best of myself

Candidate 5

People that tend to be motivated by internal self-concept seek to confront with tasks that represent an opportunity to better know themselves Certain types of tasks when performed provide information to the individuals who perform them about their abilities and personality traits It this is the case people motivated by internal self concept will be more willing to engage in such kinds of tasks

Candidate 6

Autonomy, independence, self-contained

Candidate 7

I get a lot of enjoyment from performing my tasks well

I prefer to perform tasks in which you can judge **** if the result is satisfactory

P10 When faced with alternative tasks, individuals dominated by *goal-Internalization motivation* will choose to engage in tasks that have the greatest potential of achieving the groups or organisations goals Behaviour will be sustained as long as progress towards those goals continues

Candidate 1

I don't understand the groups or organisations goals Perhaps are groups or organisations goals but perhaps are own goals, individuals goals

I understand that goal-Internalization motivation is the same as 'internal self-concept' based motivation
Also added or connected with elaboration of object towards that activity is oriented
It's an aim that permits to reach and build identity

I feel that objectives of my group are important to me

I think and feel that is it very good to contribute to reach group objectives

I feel well when I work intensively to reach the group or organisational objectives

Candidate 2

Devoted, committed to organisational goal Strong extra role behaviour, identification with organisational values, affectively and morally identified with company

Candidate 3

Goals are motivating by themselves
My behaviour is goal-directed
In my work goals determine everything I do
Goals provide me with direction
It is difficult to work effectively when no goals are provided

Candidate 4

This work gives me prestige in the peer-group

I can give leadership m doing this
I can create structures for my followers
I can contribute to the organisation

Candidate 5

Goals are those types of statements that have an intentional drive They direct actions towards the achievement of certain aims Some individuals are specially appealed by achieving goals They seem them as challenges and they are motivated to try to achieve them individually or in groups These people engage more probably in task that are means to achieve the goals

Candidate 6

Unitarianism, committed, targets

Candidate 7

I would not work for an organisation (employer) the goals of which are obscure

I like to feel that I am working for a good cause

I would rather quit than stay in an organisation which is not likely to achieve their goals

The long-term purpose of my work is more important than anything else

APPENDIX B1: Letter of introduction for the MMS Beta and MMP Beta reliability analysis

James C Ryan
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Telephone ext 5573

Dear X

I would first like to thank you for the help you have already provided with my research to date You may recall some months back receiving a questionnaire from me Thanks to the support and responses from yourself and other colleagues in DCU I have been able to examine the reliability of that questionnaire and have found it to be unsuitable for use in my PhD research

Consequently I am developing my own questionnaire and again require your help at this critical stage I have attached a beta version of this questionnaire and sincerely hope you can spare the time to complete it This questionnaire is slightly longer than the first one I sent you and you may find an element of repetition within it, but it is very important that you provide a response to every statement

I would greatly appreciate it if you could fill out the enclosed questionnaire in your own time and return it to me through the internal mail system within the next week, if possible All information gathered will be held in the strictest confidence The data gathered will only be used, by me, to test the reliabilities of the instrument and aid in the construction of a suitable questionnaire for use in my PhD research I hope you can assist me in this regard

Thanking you in advance for your assistance,
James

APPENDIX B2: MMS BETA

Measure of Motivational Sources

This questionnaire is designed to identify your attitudes towards various aspects of your life and work Below are 40 statements Please indicate your level of agreement with each statement by circling the appropriate number from 1 to 7 opposite the statement (1 Strongly Disagree to 7 Strongly Agree)

Please rate all the statements below Read each statement carefully Give your first and natural response Be accurate and honest All responses are private and confidential and no individuals will be identified from the study

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMS 3/1	I would rate 'enjoyment' very highly among reasons why someone should do a job	1	2	3	4	5	6	7
MMS 19/2	I work harder on a project if public recognition is attached to it	1	2	3	4	5	6	7
MMS 31/3	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour	1	2	3	4	5	6	7
MMS 21/4	I often make decisions based on what others will think	1	2	3	4	5	6	7
MMS 26/5	When choosing between jobs the most important criterion is 'which will provide me with a greater sense of personal achievement'?	1	2	3	4	5	6	7
MMS 36/6	When choosing an organisation to work for, I look for one that supports my beliefs and values	1	2	3	4	5	6	7
MMS 5/7	If a job were not enjoyable then I'd rather not do it	1	2	3	4	5	6	7
MMS 11/8	I would only work harder if I knew my effort would lead to greater financial reward	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMS 29/9	Decisions I make reflect the high standards that I set for myself	1	2	3	4	5	6	7
MMS 2/10	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'	1	2	3	4	5	6	7
MMS 8 11	I would only do a job if I found it enjoyable	1	2	3	4	5	6	7
MMS 17 12	It is important to me that my colleagues should approve of my work behaviour	1	2	3	4	5	6	7
MMS 33/13	I would find it very difficult to work for an organisation if I didn't agree with its missions and goals	1	2	3	4	5	6	7
MMS 22 14	I work harder when I know others are evaluating my work	1	2	3	4	5	6	7
MMS 30/15	I get great personal satisfaction from doing a job well	1	2	3	4	5	6	7
MMS 12/16	The best aspects of any job are the financial rewards and associated financial benefits	1	2	3	4	5	6	7
MMS 18/17	The recognition of ones colleagues is the most important reward for a job well done	1	2	3	4	5	6	7
MMS 6/18	If something is not enjoyable then it is not worth doing	1	2	3	4	5	6	7
MMS 32/19	I like to do work that challenges me and gives me a sense of personal achievement	1	2	3	4	5	6	7

		Strongly Disagree	Disagree	Weakly Disagree	Undecided	Weakly Agree	Agree	Strongly Agree
MMS 34/20	I have to believe in a cause before I will work hard at achieving its ends	1	2	3	4	5	6	7
MMS 10/21	If choosing between jobs the most important criterion is 'which one pays the most'?	1	2	3	4	5	6	7
MMS 27/22	I consider myself a self-motivated person	1	2	3	4	5	6	7
MMS 23/23	I give my best effort when I know that it will be seen by the most influential people in an organisation	1	2	3	4	5	6	7
MMS 7/24	I think being able to enjoy your work is more important than anything else	1	2	3	4	5	6	7
MMS 1/25	It is important that the work I do gives me a sense of enjoyment	1	2	3	4	5	6	7
MMS 25/26	It is important that I work in a job that allows me to use my skills and talents	1	2	3	4	5	6	7
MMS 16/27	I really only work for the money	1	2	3	4	5	6	7
MMS 14/28	I would readily leave any job if I were offered an alternative that pays more	1	2	3	4	5	6	7
MMS 35/29	Unless I believe in a cause, I will not work hard for it	1	2	3	4	5	6	7
MMS 38/30	I would work harder on a project if I believed in its mission and goals	1	2	3	4	5	6	7
MMS 9/31	People should always be on the lookout for better-paid jobs	1	2	3	4	5	6	7

		Strongly Disagree	Disagree	Weakly Disagree	Undecided	Weakly Agree	Agree	Strongly Agree
MMS 4/32	I would rather enjoy life than worry about the consequences of my behaviour	1	2	3	4	5	6	7
MMS 40 33	I am unconcerned with personal recognition once the goals of the group I work with are achieved	1	2	3	4	5	6	7
MMS 13'34	I only work for the financial reward that it provides me	1	2	3	4	5	6	7
MMS 24/35	When I have done a good job it is important to me that my contribution is recognised by others	1	2	3	4	5	6	7
MMS 37/36	An organisation's mission needs to be in agreement with my values for me to work hard	1	2	3	4	5	6	7
MMS 39 37	It is important to me that the goals of the organisation I work for are congruent with my personal goals	1	2	3	4	5	6	7
MMS 20/38	People should work hard for the respect and admiration of their peers	1	2	3	4	5	6	7
MMS 28 39	It is important that I work in a job that allows me to realise my potential	1	2	3	4	5	6	7
MMS 15/40	The day I look forward to most in my job is 'pay-day'	1	2	3	4	5	6	7

APPENDIX B3: Final version of MMS used in main data collection

Measure of Motivational Sources

This questionnaire is designed to identify your attitudes towards various aspects of your life and work. Below are 40 statements. Please indicate your level of agreement with each statement by circling the appropriate number from 1 to 7 opposite the statement. (1 Strongly Disagree to 7 Strongly Agree).

Please rate all the statements below. Read each statement carefully. Give your first and natural response. Be accurate and honest. All responses are private and confidential and no individuals will be identified from the study.

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMS 19/1	It is important that I work in a job that allows me to use my skills and talents.	1	2	3	4	5	6	7
MMS 4/2	If something is not enjoyable then it is not worth doing.	1	2	3	4	5	6	7
MMS 29/3	I would work harder on a project if I believed in its mission and goals.	1	2	3	4	5	6	7
MMS 18/4	When I have done a good job it is important to me that my contribution is recognised by others.	1	2	3	4	5	6	7
MMS 9/5	The best aspects of any job are the financial rewards and associated financial benefits.	1	2	3	4	5	6	7
MMS 30/6	It is important to me that the goals of the organisation I work for are congruent with my personal goals.	1	2	3	4	5	6	7
MMS 25/7	I would find it very difficult to work for a company if I didn't agree with its missions and goals.	1	2	3	4	5	6	7
MMS 24/8	I like to do work that challenges me and gives me a sense of personal achievement.	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMS 3/9	I would rate 'enjoyment' very highly among reasons why someone should do a job	1	2	3	4	5	6	7
MMS 28/10	An organisation's mission needs to be in agreement with my values for me to work hard	1	2	3	4	5	6	7
MMS 16/11	I work harder when I know others are evaluating my work	1	2	3	4	5	6	7
MMS 27/12	When choosing an organisation to work for, I look for one that supports my beliefs and values	1	2	3	4	5	6	7
MMS 10/13	I only work for the financial reward that it provides me	1	2	3	4	5	6	7
MMS 12/14	I really only work for the money	1	2	3	4	5	6	7
MMS 13/15	It is important to me that my colleagues should approve of my work behaviour	1	2	3	4	5	6	7
MMS 2/16	If choosing between two jobs, the most important criterion is 'which would be more enjoyable?'	1	2	3	4	5	6	7
MMS 1717	I give my best effort when I know that it will be seen by the most influential people in an organisation	1	2	3	4	5	6	7
MMS 21/18	Decisions I make reflect the high standards that I set for myself	1	2	3	4	5	6	7
MMS 8/19	If choosing between jobs the most important criterion is 'which one pays the most'?	1	2	3	4	5	6	7

		Strongly Disagree	Disagree	Weakly Disagree	Undecided	Weakly Agree	Agree	Strongly Agree
MMS 20/20	It is important that I work in a job that allows me to realise my potential	1	2	3	4	5	6	7
MMS 6/21	I would only do a job if I found it enjoyable	1	2	3	4	5	6	7
MMS 22/22	I get great personal satisfaction from doing a job well	1	2	3	4	5	6	7
MMS 23/23	I try to make sure that my decisions are consistent with my personal beliefs and standards of behaviour	1	2	3	4	5	6	7
MMS 1/24	It is important that the work I do gives me a sense of enjoyment	1	2	3	4	5	6	7
MMS 11/25	I would readily leave any job if I were offered an alternative that pays more	1	2	3	4	5	6	7
MMS 5/26	I think being able to enjoy your work is more important than anything else	1	2	3	4	5	6	7
MMS 14/27	I work harder on a project if public recognition is attached to it	1	2	3	4	5	6	7
MMS 15/28	I often make decisions based on what others will think	1	2	3	4	5	6	7
MMS 7/29	People should always be on the lookout for better-paid jobs	1	2	3	4	5	6	7
MMS 26/30	Unless I believe in a cause, I will not work hard for it	1	2	3	4	5	6	7

APPENDIX C1: MMP BETA

Measure of Motivational Provisions

This questionnaire is designed to identify your perceptions of your work environment and the job you do Below are 40 statements Please indicate your level of agreement with each statement by circling the appropriate number from 1 to 7 opposite the statement (1 Strongly Disagree to 7 Strongly Agree)

Please rate all the statements below Read each statement carefully Give your first and natural response Be accurate and honest All responses are private and confidential and no individuals will be identified from the study

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 40/1	This job allows me to work towards the goals of this organisation	1	2	3	4	5	6	7
MMP 32/2	I find this job challenging and personally satisfying	1	2	3	4	5	6	7
MMP 1/3	The work I do in my current job gives me a sense of enjoyment	1	2	3	4	5	6	7
MMP 2/4	I do this job because I enjoy the work	1	2	3	4	5	6	7
MMP 23/5	I know my best efforts are recognised by my work colleagues	1	2	3	4	5	6	7
MMP 24/6	I feel I am recognised for contributions I make to this organisation	1	2	3	4	5	6	7
MMP 10/7	This job pays well for the work I do	1	2	3	4	5	6	7
MMP 39/8	The goals of this organisation are reflected in my personal goals	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 20/9	I believe I have the respect and admiration of my peers	1	2	3	4	5	6	7
MMP 6/10	The work I do here is enjoyable	1	2	3	4	5	6	7
MMP 33/11	I agree with the goals and missions of this organisation	1	2	3	4	5	6	7
MMP 30/12	The work I do here gives me a sense of personal satisfaction	1	2	3	4	5	6	7
MMP 13/13	This job provides me with adequate financial reward	1	2	3	4	5	6	7
MMP 7/14	The job I do here allows me to enjoy my work	1	2	3	4	5	6	7
MMP 9/15	This salary I receive here is comparable to other jobs of this type	1	2	3	4	5	6	7
MMP 22/16	The hard work I do here is recognised by my work colleagues	1	2	3	4	5	6	7
MMP 19/17	This job allows me to be recognised for my contribution to a project	1	2	3	4	5	6	7
MMP 8/18	I find the work I do here enjoyable	1	2	3	4	5	6	7
MMP 29/19	This organisation allows me to maintain my own high standards at work	1	2	3	4	5	6	7
MMP 38/20	This job allows me the freedom to realise my potential	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 16/21	The salary I receive in this job is sufficient to meet my needs	1	2	3	4	5	6	7
MMP 4/22	I find the work I do in this organisation enjoyable	1	2	3	4	5	6	7
MMP 12/23	I am satisfied with the financial rewards of this position	1	2	3	4	5	6	7
MMP 35/24	I believe in what this organisation is trying to achieve	1	2	3	4	5	6	7
MMP 27/25	This job allows me the autonomy to work towards personal achievements	1	2	3	4	5	6	7
MMP 14 26	I am satisfied with my salary and am not currently looking for a better paid job	1	2	3	4	5	6	7
MMP 36/27	I feel this organisation supports my values and beliefs	1	2	3	4	5	6	7
MMP 25/28	This job allows me to use my skills and talents	1	2	3	4	5	6	7
MMP 34/29	I believe in the goals of this organisation	1	2	3	4	5	6	7
MMP 18/30	My colleagues recognise when I have done a good job	1	2	3	4	5	6	7
MMP 15/31	The salary I receive is a fair reflection of the work I do	1	2	3	4	5	6	7
MMP 21/32	I believe my work colleagues think highly of me	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 37/33	The values of this organisation are in line with my personal values	1	2	3	4	5	6	7
MMP 31/34	This job allows me to make decisions based on my own standards and values	1	2	3	4	5	6	7
MMP 26/35	This job gives me a great sense of personal achievement	1	2	3	4	5	6	7
MMP 3/36	I get a sense of enjoyment from the activities I engage in, in this job	1	2	3	4	5	6	7
MMP 28/37	I believe in the mission and goals of this organisation and work hard to help realise them	1	2	3	4	5	6	7
MMP 17/38	I feel my colleagues approve of my work behaviour	1	2	3	4	5	6	7
MMP 5/39	I enjoy the work I do here	1	2	3	4	5	6	7
MMP 11/40	This job rewards people fairly for the work that they do	1	2	3	4	5	6	7

APPENDIX C2: Final version of MMP used in main data collection

Measure of Motivational Provisions

This questionnaire is designed to identify your perceptions of your work environment and the job you do Below are 30 statements Please indicate your level of agreement with each statement by circling the appropriate number from 1 to 7 opposite the statement (1 Strongly Disagree to 7 Strongly Agree)

Please rate all the statements below Read each statement carefully Give your first and natural response Be accurate and honest All responses are private and confidential and no individuals will be identified from the study

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 11/1	The salary I receive is a fair reflection of the work I do	1	2	3	4	5	6	7
MMP 21/2	This job allows me the freedom to realise my potential	1	2	3	4	5	6	7
MMP 28/3	The values of this organisation are m line with my personal values	1	2	3	4	5	6	7
MMP 22/4	This organisation allows me to maintain my own high standards at work	1	2	3	4	5	6	7
MMP 5/5	I enjoy the work I do here	1	2	3	4	5	6	7
MMP 19/6	This job allows me to use my skills and talents	1	2	3	4	5	6	7
MMP 30/7	The goals of this organisation are reflected in my personal goals	1	2	3	4	5	6	7
MMP 14/8	My colleagues recognise when I have done a good job	1	2	3	4	5	6	7

		Strongly Disagree	Disagree	Weakly Disagree	Undecided	Weakly Agree	Agree	Strongly Agree
MMP 7/9	This salary I receive here is comparable to other jobs of this type	1	2	3	4	5	6	7
MMP 13/10	I feel my colleagues approve of my work behaviour	1	2	3	4	5	6	7
MMP 6/11	The job I do here allows me to enjoy my work	1	2	3	4	5	6	7
MMP 27/12	I feel this organisation supports my values and beliefs	1	2	3	4	5	6	7
MMP 15/13	This job allows me to be recognised for my contribution to a project	1	2	3	4	5	6	7
MMP 25/14	I agree with the goals and missions of this organisation	1	2	3	4	5	6	7
MMP 3/15	I get a sense of enjoyment from the activities I engage in, in this job	1	2	3	4	5	6	7
MMP 8/16	This job pays well for the work I do	1	2	3	4	5	6	7
MMP 10/17	This job provides me with adequate financial reward	1	2	3	4	5	6	7
MMP 12/18	The salary I receive in this job is sufficient to meet my needs	1	2	3	4	5	6	7
MMP 1/19	The work I do m my current job gives me a sense of enjoyment	1	2	3	4	5	6	7
MMP 24/20	I find this job challenging and personally satisfying	1	2	3	4	5	6	7

		Strongly Disagree	*Disagree*	*Weakly Disagree*	*Undecided*	*Weakly Agree*	*Agree*	*Strongly Agree*
MMP 2/21	I do this job because I enjoy the work	1	2	3	4	5	6	7
MMP 29/22	I believe in the mission and goals of this organisation and work hard to help realise them	1	2	3	4	5	6	7
MMP 20/23	This job gives me a great sense of personal achievement	1	2	3	4	5	6	7
MMP 9/24	I am satisfied with the financial rewards of this position	1	2	3	4	5	6	7
MMP 18/25	I feel I am recognised for contributions I make to this organisation	1	2	3	4	5	6	7
MMP 23/26	The work I do here gives me a sense of personal satisfaction	1	2	3	4	5	6	7
MMP 17/27	The hard work I do here is recognised by my work colleagues	1	2	3	4	5	6	7
MMP 4/28	I find the work I do in this organisation enjoyable	1	2	3	4	5	6	7
MMP 26/29	I believe in what this organisation is trying to achieve	1	2	3	4	5	6	7
MMP 16/30	I believe I have the respect and admiration of my peers	1	2	3	4	5	6	7

APPENDIX D: SERPP

Self-evaluation of Research Profile and Performance

Recent investigation suggests that research scientists working in the university setting have a very accurate perception of their position within the scientific community

This measurement instrument utilises this perception by allowing scientists to evaluate their position in the scientific community across three dimensions Institutional, National and International All responses given in the following sections will be held in the strictest confidence and no individuals will be identified from this study

Research Performance and Profile at the Institutional Level

The institutional dimension refers to your standing as a researcher in your institution, with 5 being the very highest score and 1 being the very lowest score

For example a score of 5 may refer to an individual who has a high publication rate in comparison to their peers, whose research is well regarded and respected by their colleagues, and is generally seen as one of the 'shining lights' of the research faculty Such individuals may have also won special research awards within their institution

A score of 3 may represent an individual who has an average but consistent level of research productivity, and who contributes m a moderate way to the research profile of the institution in which they work

A score of 1 may represent an individual who, for whatever reason, has not published work for several years, is not active on a current research project and does little to contribute to the research profile of their institution

I would now ask you to rate yourself on the five point scale below, keeping in mind the examples given above

Institutional Profile and Performance

5
4
3
2
1

Research Performance and Profile at the National Level

The national dimension refers to your standing as a scientific researcher on a national level Again with 5 being the highest score and 1 being the lowest

For example a score of 5 may refer to an individual whose research would be well know and respected by his/her colleagues across the country He/she would be easily recognised as the national expert in their area of specialisation Colleagues working in the same research area may also consistently refer to his/her work They may also have won national science or research awards, and large grants to fund their research

A score of 3 may represent an individual who would be known nationally for their contributions to a specialist area, but may not be necessarily seen as a leader in that field Their work may receive occasional citation from researchers in the same area, and they may be successful in attaining moderate funding for their research

A score of 1 may represent an individual whose research is relatively unknown They may produce a very small number of research publications that are not widely cited They may also be generally unknown on a national level outside of a small group of colleagues from other institutions

I would now ask you to rate yourself on the five point scale below, keeping in mind the examples given above

National Profile and Performance

5
4
3
2
1

Research Performance and Profile at the International Level

The international dimension refers to your standing as a scientific researcher on an international level Again with 5 being the highest score and 1 being the lowest

For example a score of 5 may refer to an individual whose research would be well know and respected by his/her colleagues across the world He/she would be easily recognised as the international expert in their area of specialisation Colleagues working in the same research area would consistently refer to his/her work They may also have won international science or research awards, or have been nominated or short listed for such awards

A score of 3 may represent an individual who would be known internationally for their contributions to a specialist area, but may not be necessarily seen as the leader in that field Their work would be regularly cited from researchers in the same area, and they would be successful in attaining funding for their research

A score of 1 may represent an individual whose research is relatively unknown internationally They may produce a very small number of research publications that are not widely cited They may also be generally unknown on an international level outside of a small group of colleagues from other institutions

I would now ask you to rate yourself on the five point scale below, keeping in mind the examples given above

International Profile and Performance

5
4
3
2
1

Thank you for the time and effort you have spent on completing this self-evaluation exercise The responses you have given are an integral part of my research I would once again like to ensure participants that all the information gathered will be held in the strictest confidence and no individuals will be identified by the study

APPENDIX E: Measure of organisational characteristics

Organizational Culture Survey Revised.

This questionnaire is designed to measure various aspects of your work environment Below are 41 statements Please indicate your level of agreement with each statement by circling the appropriate number from 1 to 5 opposite the statement (1 *To a very little extent* to 5 *To a very great extent*)

Please rate all the statements below Read each statement carefully Give your first and natural response Be accurate and honest All responses are private and confidential and no individuals will be identified from the study

		To a very little Extent	*To a little extent*	*To some extent*	*To a great extent*	*To a very great extent*
OEQ 38/1	Job seekers are more attracted to work for this Organisation than similar ones in the industry	**1**	**2**	**3**	**4**	**5**
OEQ 4/2	People I work with function as a team	**1**	**2**	**3**	**4**	**5**
OEQ 13/3	Working here feels like being part of a family	**1**	**2**	**3**	**4**	**5**
OEQ 20/4	I have a say in decisions that affect my work	**1**	**2**	**3**	**4**	**5**
OEQ 16/5	I get enough information to understand the big picture here	**1**	**2**	**3**	**4**	**5**
OEQ 24/6	Job requirements are made clear by my supervisor	**1**	**2**	**3**	**4**	**5**
OEQ 19/7	I get the information I need to do my job well	**1**	**2**	**3**	**4**	**5**
OEQ 22/8	This organisation values the ideas of workers at every level	**1**	**2**	**3**	**4**	**5**

		To a very little Extent	*To a little extent*	*To some extent*	*To a great extent*	*To a very great extent*
OEQ 37/9	The company makes every effort to attract and hire the most highly skilled people in the industry	**1**	**2**	**3**	**4**	**5**
OEQ 32/10	Decisions made at meetings get put into action	**1**	**2**	**3**	**4**	**5**
OEQ 40/11	The people who join this company "fit in" well with those already employed here	**1**	**2**	**3**	**4**	**5**
OEQ 27/12	My supervisor delegates responsibility	**1**	**2**	**3**	**4**	**5**
OEQ 12/13	This organisation treats people in a consistent and fair manner	**1**	**2**	**3**	**4**	**5**
OEQ 6/14	People I work with constructively confront problems	**1**	**2**	**3**	**4**	**5**
OEQ 18/15	I know what's happening in work sections outside my own	**1**	**2**	**3**	**4**	**5**
OEQ 41/16	The company takes sufficient steps to ensure that new employees are aware of "how things are done around here"	**1**	**2**	**3**	**4**	**5**
OEQ 30/17	My supervisor is a good listener	**1**	**2**	**3**	**4**	**5**
OEQ 11/18	This organisation respects its workers	**1**	**2**	**3**	**4**	**5**
OEQ 28/19	My supervisor is approachable	**1**	**2**	**3**	**4**	**5**

		To a very little Extent	*To a little extent*	*To some extent*	*To a great extent*	*To a very great extent*
OEQ 36/20	Meetings tap the creative potential of the people present	**1**	**2**	**3**	**4**	**5**
OEQ 31/21	My supervisor tells me how I'm doing	**1**	**2**	**3**	**4**	**5**
OEQ 29/22	My supervisor gives me criticism in a positive manner	**1**	**2**	**3**	**4**	**5**
OEQ 34/23	Our discussions in meetings stay on track	**1**	**2**	**3**	**4**	**5**
OEQ 5/24	People I work with are co-operative and considerate	**1**	**2**	**3**	**4**	**5**
OEQ 21/25	I am asked to make suggestions about how to do my job better	**1**	**2**	**3**	**4**	**5**
OEQ 35/26	Time in meetings is time well spent	**1**	**2**	**3**	**4**	**5**
OEQ 23/27	My opinions count in this organisation	**1**	**2**	**3**	**4**	**5**
OEQ 15/28	This organisation motivates people to be efficient and productive	**1**	**2**	**3**	**4**	**5**
OEQ 7/29	People I work with are good listeners	**1**	**2**	**3**	**4**	**5**
OEQ 9/30	Labour and management have a productive working relationship	**1**	**2**	**3**	**4**	**5**
OEQ 10/31	This organisation motivates me to put out my best efforts	**1**	**2**	**3**	**4**	**5**

		To a very little Extent	*To a little extent*	*To some extent*	*To a great extent*	*To a very great extent*
OEQ 33/32	Everyone takes part in discussions at meetings	1	2	3	4	5
OEQ 14/33	There is an atmosphere of trust in this organisation	1	2	3	4	5
OEQ 1/34	People I work with are direct and honest with each other	1	2	3	4	5
OEQ 2/35	People I work with accept criticism without becoming defensive	1	2	3	4	5
OEQ 26/36	My supervisor takes criticism well	1	2	3	4	5
OEQ 39/37	The selection procedures used here (e g psychological tests, interviews) are effective in selecting the "right" people	1	2	3	4	5
OEQ 3/38	People I work with resolve disagreements co-operatively	1	2	3	4	5
OEQ 8/39	People I work with are concerned about each other	1	2	3	4	5
OEQ 25/40	When I do a good job my supervisor tells me	1	2	3	4	5
OEQ 17/41	When changes are made the reasons why are made clear	1	2	3	4	5

APPENDIX F: Letter of introduction for scientists participating in the main data collection phase of the current study

James C Ryan,
Q107 DCUBS,
Dublin City University
Glasnevin,
Dublin 9
Ireland

Dear X,

I am writing to request your assistance in a very important aspect of my PhD studies Firstly let me briefly introduce myself and give you an overview of my research My name is James Ryan and I am an organisational psychologist conducting my PhD research on scientists and academic researchers I am primarily interested in the motivation of research scientists and how their organisational environment influences their motivational profile (if at all)

At this critical stage of my research I am looking for research academics that are willing to complete a questionnaire I have developed, which will provide me with invaluable information on this issue The questionnaire covers several dimensions of individual motivation, job satisfaction, organisational characteristics, research profile and some biographical details

I have enclosed the questionnaire with this letter in the sincerest hope that you will support me in my research efforts and complete and return the questionnaire to me The questionnaire takes about 30 minutes to complete, so I hope it will not distract you too much from your important work Also let me stress that no individuals or orgamsations will be identified from the study and all data collected will only be examined at the group level to determine general relationships between variables

I understand that these are busy times and I am very aware of the heavy workloads of academic scientists, but I sincerely hope that you can facilitate my research if at all possible, as the completion of my PhD depends on the participation and support of scientists such as yourself

If you have any questions or queries regarding specific aspects of my research please feel free to contact me at james ryan9@mail dcu ie

Thank you for your time and effort
Sincerely,
James C Ryan

APPENDIX G: Measurement items contained in each factor of the OCS Revised.

Presented below are the items that make up each of the factors of the OCS Revised whose results are presented in chapter nine

Factor 1 Teamwork

People I work with are direct and honest with each other
People I work with accept criticism without becoming defensive
People I work with resolve disagreements co-operatively
People I work with function as a team
People I work with are co-operative and considerate
People I work with constructively confront problems
People I work with are good listeners
People I work with are concerned about each other

Factor 2 Morale

Labour and management have a productive working relationship
This organisation motivates me to put out my best efforts
This organisation respects its workers
This organisation treats people in a consistent and fair manner
Working here feels like being part of a family
There is an atmosphere of trust in this organisation
This organisation motivates people to be efficient and productive

Factor 3 Information Flow

I get enough information to understand the big picture here
When changes are made the reasons why are made clear
I know what's happening in work sections outside my own
I get the information I need to do my job well

Factor 4 Involvement

I have a say in decisions that affect my work
I am asked to make suggestions about how to do my job better
This organisation values the ideas of workers at every level
My opinions count in this organisation

Factor 5 Supervision

Job requirements are made clear by my supervisor
When I do a good job my supervisor tells me
My supervisor takes criticism well
My supervisor delegates responsibility
My supervisor is approachable
My supervisor gives me criticism in a positive manner
My supervisor is a good listener
My supervisor tells me how I'm doing

Factor 6 Meetings

Decisions made at meetings get put into action
Everyone takes part in discussions at meetings
Our discussions in meetings stay on track
Time in meetings is time well spent
Meetings tap the creative potential of the people present

Factor 7 Selection

The company makes every effort to attract and hire the most highly skilled people in the industry
Job seekers are more attracted to work for this Organisation than similar ones in the industry
The selection procedures used here (e g psychological tests, interviews) are effective in selecting the "right" people
The people who join this company "fit in" well with those already employed here
The company takes sufficient steps to ensure that new employees are aware of "how things are done around here"

APPENDIX H: Scientists biographical questionnaire

Biographical Questionnaire

Your answers to these questions will provide useful background information All information given is completely confidential The data collected in this section will only be used for grouping purposes during data analysis Individuals taking part in this study will not be identified Nor will the department of institute in which you work be identified

Please circle the answers that apply to you, or enter the required information in the space provided

Gender and Age

Sex *Male/Female*

Age *Under25/25-34/35-44/45-59/60+*

Your education and profession

Please state the name of the academic institution and department in which you work

_____

Please state your grade and title within the department in which you work

_____

In what year did you complete your PhD _____

How many years have you worked in your current job_____

Did the department you currently work in take part in the 'Research Assessment Exercise 2001' carried out by the Higher Education Authority in the UK?
Yes/no

If so do you know what rank your department received?
5*/5/4/3a/3b/2/1

Was your research work included as part of the department's submission to the Research Assessment Exercise 2001? ***Yes/no***