AN EVALUATION OF THE KEY FACTORS THAT INFLUENCE A SOUTH AFRICAN-BASED FIRM TO IMPLEMENT ENVIRONMENTAL MANAGEMENT

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DECLARATION

I declare that this thesis is my own, unaided work. It is being submitted for the Master of Science degree in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

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ABSTRACT

International research indicates that the practice of environmental management may lead to profitability and competitive advantage for the firm. But this theory has not been tested in South Africa. This lack of empirical evidence led the researcher to the primary research question: **does environmental management increase a firm's profitability in South African-based firms?**

The secondary objective of the study is to determine which factors cause South African-based firms to implement environmental management strategies.

Based on a comprehensive literature review, this study delineates the concepts environmental management and profitability and examines the causal relationship between the two factors. Data is collected from firms operating in ten sectors in South Africa using a cross-sectional online mail survey. A proposed research model and hypotheses are tested using confirmatory factor analysis and path analysis with latent variables. The SAS System is used for statistical analysis.

The test of the structural model supports the proposed hypothesis that environmental management increases competitive advantage in South African-based firms. Environmental management, however, is limited to the minimization of natural resource consumption and competitive advantage is determined by the strength of the firm's relationships with its stakeholders. In turn, top management positively influences the strength of these relationships.

South African firms follow a strategy of pollution control as opposed pollution prevention. One of the main contributing factors to compliance with regulation in environmental management (as opposed to innovation) is the lack the technical skill and knowledge in both government and the manufacturing sector.

I dedicate this work to:

My husband Richard

My son Michael

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LIST OF EQUATIONS

LIST OF SYMBOLS

V	Variable
F	Factor
n	Sample size
***re*%**	Response rate
n^a	Actual sample size
α	Cronbach's coefficient alpha
N	Number of test items in the research instrument
S	Sum of the scale score for each indicator variable
S^2	Variance of the summated scale score
C	Covariance between latent factors
E	Error term for endogenous variables
L	Factor loading of indicator variable on factor
VAR	Variance exhibited by indicator and latent variables
r_{xy}	Pearson's correlation coefficient
X	Raw score of variable X
Y	Raw score of variable Y
L_i	Standardized factor loading
M_o	Null model
M_u	Uncorrelated factor model
M_t	Theoretical model
M_{r1}	Revised model 1
M_{r2}	Revised model 2
M_{r3}	Revised model 3
M_{r4}	Revised model 4
M_m	Measurement model

1. INTRODUCTION

The environment is no longer a concern only for environmental conservationists and Greenpeace – it has become a global concern that affects us all – world governments, business, industry and communities alike. Industrial activities in the past have created serious ecological problems including malnutrition, soil erosion, gross pollution, loss of biodiversity and global warming (Shrivastava 1995; Simmons 1981). The main concern is that the increasing world population and consequent use of natural resources are destroying the usefulness of the environment and its life-supporting ability (Mohr and Fourie 2000). It has now become crucial to develop a sustainable global economy (Hart 1997). The director of the Economics and Population Program of the World Resources Institute (Faeth 2002; cited by Fields 2002) states that, of the one hundred largest economic actors in the world, fifty are countries and fifty are corporations. Thus, to achieve global sustainable development, it is necessary to transform global business and industry along ecologically sound principles (Shrivastava 1995).

Hart (1997) states that companies have accepted their responsibility towards the environment. But it is a grudge acceptance because of the belief that sound environmental practice erodes a firm's competitiveness (Porter and van der Linde 1995a). The general sentiment amongst corporate managers in South Africa is that environmental management is a soft issue as opposed to the real business issues such as costs and production (Sunter 1997). This is evident from a study conducted in the food, textile and chemical industries of South Africa that indicated that "firms do not appear to appreciate the significance of their impact on the environment and that environmental issues are not factored into their strategic decision-making" (Patel and Peart 1998, p.6).

Historically, South Africa competed in the world market because its companies offered access to comparatively low cost inputs - capital, labour, energy and raw materials. But globalisation has changed this concept of competitive advantage (Porter and van der Linde 1995b). Global competitiveness is now defined by the rapid adoption of new technology and international standards - and how productively a company uses its resources (Patel and Peart 1998). Visser (1998) and Newton-King (2003; cited by Botha 2003) state that if South African business want to remain competitive globally and benefit from increased international investment, it needs to change its environmental mindset and adopt the global standards of business practice. One of these standards is environmental and social responsibility, which is now regarded as one of the attributes of a world-class company (Sunter 1997).

The performance of a listed company in South Africa is currently being judged on three criteria, namely its social, economic and environmental performance, collectively called the triple bottom line (Naidoo 2002). In 2002, the King Report II called for corporate disclosure on specific issues such as health and safety, HIV/AIDS and environmental corporate governance, as well as social investment and human capital investment (Ernst & Young 2003). In 2004, the Johannesburg Stock Exchange plans to launch the first South African Socially Responsible Investment index which purpose is to benchmark the social and environmental performance of South African companies with global standards, thereby promoting investment in South Africa (Newton-King 2003; cited by Botha 2003).

Being a South African-based environmentally and socially responsible company, however, is a great challenge since government and business have to contend with competing issues such as the HIV/AIDS pandemic, unemployment, poverty and employment equity. An illustrative example is the recent promulgation of plastic bag regulations by the Department of Environmental Affairs and Tourism that require customers to pay for the use of plastic bags. South African labour argues that the positive effect of the plastic bag regulations on the environment is counteracted by the negative effect on employment (Letsoalo 2003; SABC News 2003). They state that, since the implementation of the regulations, the demand for plastic bags has dropped by between eighty and ninety percent with massive loss of employment as a result. It is specifically this conflict between environmental consideration and other economic costs that promote the perception that a trade-off exists between environmental initiatives and the economic performance of a firm.

The International Chamber of Commerce adopted the following principle for sustainable development on the 27th November 1990: "business shares the view that there should be a common goal, not a conflict, between economic development and environmental protection, both now and for future generations" (International Chamber of Commerce 1990; cited by North 1997). In support of this vision, the one hundred and seventy eight states of the United Nations convened the first International Conference on Environment and Development in Rio de Janeiro, Brazil in 1992. The objective of the conference was to address global environmental issues and recommend global solutions – these included the Rio Declaration on Environment and Development, the Statement of Principles for the Sustainable Management of Forests and Agenda 21 (United Nations Division for Sustainable Development WSSD Plan of Implementation 2003). On the 26th August 2002, Johannesburg hosted the ten year follow-up of this international event (Johannesburg World Summit 2002). The purpose of the 2002 summit was to look at the progress the world had been made in implementing Agenda 21 and to develop a broad action plan for global sustainable development in the next century.

With its hosting of the conference, South Africa committed itself to promoting global sustainable development. The South African Research and Technology Foresight Report published by the Department of Arts, Culture, Science and Technology in 2002 identified environmental management as one of the key technologies to yield the greatest economic and social benefits for South Africa in the next ten to twenty years (Shreiner 2002). But what is the financial implication of sustainable business practice for South African-based firms?

International research on the link between environmental management and the profitability or competitiveness of firms has produced mixed results. Dechant and Altman (1994) and Klassen and McLaughlin (1996) found that many organizations view the relationship between environmental management and economic performance as polar opposites. Porter and van der Linde's research (1995a,b) indicate that firms regard environmental management only as compliance with environmental regulations and that this erodes a firm's competitiveness. Aupperle, Carroll and Hatfield (1985) did not find any relationship between a firm's social responsibility initiatives and its profitability – in this study social responsibility included environmental initiatives.

Alternative arguments suggest that environmental management may increase the financial performance and the economic competitiveness of a firm. Piasecki, Fletcher and Mendelson (1995) state that most executives in the United States of America see environmental decisions as reshaping all aspects of their business functions – from acquisitions and facility operations to manufacturing, design and distribution. Empirical research by Russo and Fouts (1997) and Dechant and Altman (1994) propose that environmental management does increase the financial performance and competitive advantage of a firm. Reinhardt (1999, p.155) states that "effective management of environmental risk can itself be a source of competitive advantage." Shrivastava (1995) argues that the application of environmental technologies in a firm can minimize the ecological impact of production whilst enhancing a firm's competitiveness and Banerjee and Iyer (2003) found that corporate environmentalism is possible when top management perceives added competitive advantage and economic value to the firm.

The International Chamber of Commerce stated in 1990 that "managers now grasp that effective environmental management is a potential competitive advantage in a saturated market" (International Chamber of Commerce 1990; cited by North 1997).

Currently, no empirical research exists to indicate that there is a relationship between environmental management and profitability in South African-based firms.

This paper thus seeks to answer the following research question:

> **Does environmental management increase a firm's profitability in South African-based firms?**

The primary research objective is to determine whether there is a positive relationship between environmental management and profitability. In support of the research question, the researcher aims to develop measures for the concepts environmental management and profitability to enable it to be measured quantitatively.

The research hypothesis is that the implementation of environmental management in a firm increases the profitability of the firm.

The null hypothesis is that no causal link exists between environmental management and profitability in a South African-based firm.

A study conducted by Rawicz (1994) indicates that South African-based firms implement environmental management for the following reasons:

1. To comply with environmental legislation and regulations and to comply with waste and pollution minimization standards;
2. To satisfy growing public pressure and social demands;
3. To meet new market demands;
4. To minimize risk and liability exposure;
5. To meet the requirements of international trading partners.

The secondary research question of this paper is thus:

What are the key factors that cause a South African-based firm to implement environmental management strategies?

It follows that the research objective is to determine these factors.

A survey research method was applied and deductive research was conducted to test the ten research hypotheses generated in the study. The concepts environmental management and profitability were operationalised to develop the test items for a research questionnaire which was then administered via email and the Internet.

The sampling frame of South African-based firms was divided into ten industry sectors and disproportionate stratified random sampling was applied to obtain a representative sample. A sample size of one thousand cases was obtained and the unit of analysis of the study was top and middle management of firms. The ten sectors included: Mining, Healthcare (hospitals), Textiles, Chemicals, FMCG (fast moving consumer goods), Petroleum, Pulp and paper, Utilities, Food processing and Hospitality (hotels).

The causal relationship between environmental management and profitability was proposed using a structural equation model. A two-step process suggested by Hatcher (1994) was followed to develop the model: first, confirmatory factor analysis was applied to test the measurement of indicator and latent variables and second, path analysis with latent variables was used to test the causal relationships between latent factors. The statistical program SAS (Statistical Analysis System) was used for descriptive and inferential statistical analysis.

Chapter 2 of this report presents the literature review for the study and Chapter 3 presents the research methodology and research design. Chapter 4 outlines the statistical techniques used for data analysis. Chapter 5 presents the study results and statistical analysis. In Chapter 6 the results are analysed and interpreted.

Conclusions are given in Chapter 7 and the study limitations are discussed as well. Finally, recommendations are presented in Chapter 8.

2. LITERATURE REVIEW

2.1 Environmental Management

On the 27th November 1990 the Executive Board of the International Chamber of Commerce published the following statement: one of the greatest challenges the world faces in the next decade is to develop a common goal between economic development and environmental protection (International Chamber of Commerce 1990; cited by North 1997). They called for sustainable industrial and economic practice in order to meet our current resource needs without jeopardizing the ability of future generations to meet theirs (Hart 1997; Shrivastava 1995). Simmons (1981) states that the life-supporting capability of the environment and its ability to absorb wastes is negatively affected by the increase in utilization and processing of materials from the environment. Global warming, ozone depletion, malnutrition, soil erosion, air, soil and water pollution, poverty, loss of biodiversity and destruction of environmental beauty are global symptoms of the humans' historic lack of concern for the environment (Sarkis and Rasheed 1995; Schreiner 2002; Shrivastava 1995; Simmons 1981).

The world recognized this environmental threat and convened the first United Nations Conference on Environment and Development in Rio de Janeiro, Brazil in 1992 – the objective of the conference was to address global environmental issues and recommend solutions (United Nations for Sustainable Development WSSD Plan of Implementation 2003). At the conference, the United Nations adopted three global environmental principles: the Rio Declaration on Environment and Development, the Statement of Principles for the Sustainable Management of Forests and Agenda 21. The principles of the Rio Declaration promote global partnerships to conserve, protect and restore the Earth's ecosystem and support an international economic system that would lead to both economic growth and sustainable development in all countries (Report of the United Nations Conference on Environment and

Development 1992). Agenda 21 recommends that governments, business and industry should collaborate to promote global sustainable development (United Nations Division for Sustainable Development Agenda 21 Chapter 30). On the 26th August 2002 Johannesburg hosted the ten year follow-up of this international event. The purpose of the summit was to look at the progress that had been made in implementing Agenda 21 and to develop a broad action plan for global sustainable development in the next century.

The advent of the United Conference on Environment and Development and the emergence of a concerned, environmentally-conscious global community and consumers have had a significant impact on international business practice (Bennet, Freierman and George 1993; Hart 1997; Patel and Peart 1998; Porter and van der Linde 1995a,b; Rawicz 1994; Skivington 1994). Shrivastava (1995, p.184) states that "if the world economy shifts towards an ecological orientation, it will change the competitive landscape of industries in terms of consumer preferences and demands, industrial regulations and competitive opportunities". According to Hart (1997) sustainable development now constitutes one of the biggest opportunities in the history of commerce. Historically, however, firms did not include environmental issues in their strategic decision making, pollution control is still employed in the form of end-of-pipe technologies as opposed to pollution prevention, firms view environmental management only as compliance to environmental regulation, environmental initiatives are not communicated in financial terms or disclosed to stakeholders and the public and environmental management is generally considered non-profitable (Dechant and Altman 1997; Klassen and McLaughlin 1996; Hart 1997; Patel and Peart 1998; Piasecki, Fletcher and Mendelson 1999; Porter and van der Linde 1995; Sarkis and Rasheed 1995; Russo and Fouts 1997).

In 2002, the market value of the United States environmental management industry was estimated at two hundred and fifty billion dollars and it is currently growing at five percent per year (Shreiner 2002). This market refers to the supply of pollution control, reduction, clean-up and waste-handling equipment and related services. Visser (2000) states that most leading multinational companies are now spending between one percent and five percent of their annual turnover on environmentally related costs or investments. Both the FTSE-350 and the Dow Jones have launched a sustainability index which measures the environmental performance of companies for investment purposes (Visser 2000). The Johannesburg Stock Exchange is planning to launch its Socially Responsible Investment Index in 2004 (Newton-King 2003; cited by Botha 2003). Companies are now being measured on three criteria called the triple bottom line, namely economic, social and environmental performance (Fields 2002). Sunter (1997) states that social and environmental responsibility are two prerequisites for a world-class company but that a balance is required between economic development and environmental conservation.

Managers are starting to grasp that environmental management is a potential competitive advantage in a saturated market and most executives begin to see environmental decisions as reshaping all aspects of their business functions (International Chamber of Commerce; cited by North 1997; Skivington 1994). Sarkis and Rasheed (1995, p.17) define the new business paradigm of environmental consideration as follows:

> Environmentalism is no longer an issue of reluctant compliance with regulatory requirements. In the last decade, it has increasingly emerged as a potential mechanism for gaining competitive advantage and has become an important aspect of strategic management.

A review of the literature has identified various reasons why firms now adopt sustainable business practices. Patel and Peart (1998) state that globalisation increases competitive pressures which drive the increasingly rapid adoption of technology by firms as well as providing greater access to new technologies and resources. Rawicz (1994) mentions the following five factors as reasons for firms adopting sustainable business practice:

1. Compliance with environmental legislation and regulation.
2. Response to growing public pressure.
3. New market demands.
4. Minimisation of risk and liability exposure.
5. Requirements of international trading partners.

Elkington (2002; cited by Fields 2002) states that corporations are accepting sustainability for the following reasons. First, social and environmental responsibility is a criterion for investment. Second, the media now highlight companies that act with environmental irresponsibility and this harms a company's image and reputation. Third, environmental regulations cause a barrier-to-market entry if not complied with. Fourth, peer pressure amongst top management promotes sustainable business practice and fifth, employees are concerned about environmental issues.

2.2 Competitive Advantage

Sustainable business practice is slowly becoming a prerequisite to international and local trade. Various authors have opposed and argued the view that corporate environmentalism is only compliance to regulation, involving a trade-off between environmental and economic performance, and challenged firms to recognize it as potential competitive advantage.

Schiffmann and Kanuk (1991, p.639) make the following statement about the corporate philosophy of a company:

> Some companies recognize that socially responsible activities improve their image among consumers, stockholders, the financial community, and other

> relevant publics. Thus, ethical and socially responsible practices are simply good business: they result in a favourable image, and ultimately in increased sales and decreased costs of doing business.

Thus, the first step to achieving competitive advantage by environmentalism is the full integration of environmental decisions in corporate strategy. A company's environmental strategy defines its orientation towards legal compliance, pollution prevention, stakeholder involvement, environmental disclosure, choice of technologies and environmental responsibility. Piasecki, Fletcher and Mendelson (1999) observed that decision makers in firms still only respond to environmental choices in a manufacturing or waste management context, thus limiting their management and strategic choices. Hart (1997) supports this view and found that environmental strategy only consists of discrete projects aimed at controlling pollution. But unless environmentalism is viewed as an integral part of corporate business strategy, real progress towards sustainability is unlikely (Beaumont, Pederson and Whitaker 1993). A fully integrated environmental strategy shapes a company's relationship with all stakeholders, including customers, suppliers, government and shareholders (Hart 1997).

Dechant and Altman (1994) found that, in companies that view environmentalism as part of strategic management, product design and development, the choice of process technology and raw materials as well as management programs are all affected. Examples of such companies include Johnson and Johnson, The Body Shop, Procter and Gamble and Lever Brothers (Dechant and Altman 1994). Finally, such companies are also known as environmental educators and promote environmental awareness both internally and externally to their firms (Dechant and Altman 1994; Hart 1997).

Russo and Fouts (1997) argue that a firm achieves competitive advantage once it moves from a compliance environmental strategy to a proactive pollution prevention strategy. The difference lies in the application of technology. In the compliance environmental strategy, a firm complies with minimum environmental legal standards by implementing end-of-pipe pollution treatment technology. This technology is the addition of pollution-removing or filtering devices to the existing process; it can be bought off-the-shelf and require no additional expertise or skills in its management (Russo and Fouts 1997). The technology is therefore available to competitors and provides no competitive advantage to the firm.

In opposition, the proactive environmental policy employs its "tangible resources (financial reserves, plant, equipment and raw materials) and intangible resources (reputation, technology, culture, training, expertise, employee commitment and loyalty)" to achieve competitive advantage (Russo and Fouts 1997, p.537). This policy promotes "design for environmental quality" which affects the choice of raw materials, operations, products, packaging, transportation and disposal methods to minimise or eliminate the generation of environmentally harmful wastes (Dechant and Altman 1994; Hart 1997; Reinhardt 1999; Shrivastava 1995). Such design, or redesign of existing plant and equipment, deploys technological advantage within the firm that is not readily available to competitors. In addition, intellectual capital is created whereby the skills of employees in manufacturing, research and development, marketing and management are increased (Russo and Fouts 1997).

Porter (Quick MBA Strategic Management 2003) identified two routes for a firm to achieve competitive advantage: firstly, via the cost advantage pathway and secondly, via the differentiation advantage pathway which generates revenue for the firm. He states that competitive advantage exists when the firm is able to deliver the same benefits as competitors but at a lower cost (cost advantage), or deliver benefits that exceed those of competing products (differentiation advantage). Klassen and McLaughlin (1996) and Reinhardt (1999) apply these principles to environmental economics and state that the financial performance of a firm is affected by strong environmental performance through both revenue and cost pathways. These concepts are discussed below.

Firstly, competitive advantage via the cost pathway: Porter and van der Linde (1995a, p.122) state that "pollution is a form of economic waste". Air emissions, effluent, solid waste, energy and water consumption all cost money in three ways: firstly, the ineffective utilisation of resources that generates this loss; secondly, the cost of handling, storage, treatment and disposal of discharges and thirdly, the wasted resources when useable materials are discarded by the consumer. Pollution is therefore a direct result of poor environmental standards and poor process and product design (Porter and van der Linde 1995a). Innovation, or "environmental product design" (Dechant and Altman 1994, p.13) utilises resources more productively and minimises the cost associated with pollution treatment. "Manufacturing-for-the-environment" is a term coined by Shrivastava (1995, p.187) which explains the redesign of production systems to reduce environmental impacts, the use of cleaner technologies, the application of higher-efficiency production techniques, minimization of waste at source and maximization of fuel and energy efficiency. Pollution prevention employs tools such as life-cycle analysis and design for the environment to prevent pollution before it occurs, thereby minimizing or eliminating the cost of pollution (Friedrich 2003).

Secondly, revenue can be generated through product design and differentiation (Porter and van der Linde 1995; Shrivastava 1995). Henderson (1994) argues that the cost of environmental management of a product has historically not been included in the market price of the product. Companies can command higher prices for "green" products that offer greater environmental benefits or impose smaller environmental costs than its competitors, thereby increasing sales in the target market (Porter and van der Linde 1995a). Shrivastava (1995) states that product differentiation, as a source of new product ideas, can create and expand market demand. Reinhardt

(1999, p.151) names the following three conditions required for successful environmental product differentiation:

> First, the company has identified customers who are willing to pay more for environmentally friendly products. Second, it has been able to communicate its product's environmental benefits credibly. And third, it has been able to protect itself from imitators for long enough to profit on its investment.

The revenue pathway to competitive advantage is also achieved by promoting the company as environmentally conscious. An environmental reputation in itself is a source of market advantage in that it increases the sales of the company amongst environmentally-conscious consumers (Russo and Fouts 1997). The Economist (1994, p.71; cited by Russo and Fouts 1997) has argued that society is entering "the era of corporate image, in which consumers will increasingly make purchases on the basis of a firm's whole role in society: how it treats its employees, shareholders and local neighbourhoods". Klassen and McLaughlin (1996) present empirical evidence showing an average increase in the market valuation of a firm of approximately eighty one million dollars following a positive environmental announcement.

2.3 Environmental Legislation and Regulations

Agenda 21 (United Nations Division for Sustainable Development Agenda 21 Chapter 30) recommends that governments should identify and implement normative measures such as laws, legislations and standards to promote cleaner production in enterprises. Porter and van der Linde (1995a, p.120) state that "the need for regulation to protect the environment gets widespread but grudging acceptance: widespread because everyone wants a liveable plant, grudging because of the lingering belief that environmental regulation erodes competitiveness." Regulations were often resisted by business and considered expensive and necessary only to protect the environment (Anderson 1999). Henderson (1994) argues that command-and-control measures such as governmental regulation do set standards for environmental quality and pollution control, but that it presents certain problems. Henderson (1994) states that regulation is inflexible because it requires each polluter to use the same standard whilst the cost to polluters is likely to vary from producer to producer. Regulation may also restrict technological development and can be costly and difficult to enforce. Forbes (2003, p.1) concurs – "environmental compliance is considered an additional cost which will negatively impact the bottom line."

Almost three decades ago, Van Niekerk (1976) stated that the protection of our planet's environment must be regarded as an inherent policy of international law, as significant as international peace and security, human rights and the outlaw of racial discrimination. In the following years several international agreements were developed to protect the environment. Included were the Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and their Disposal -entry into force the 5th May 1992 (Secretariat of the Basel Convention – Introduction 2003), the Kyoto Protocol on Climate Change -entry into force on the 21st March 1994 (Oberthür 1999), and the Montreal Protocol on Substances that Deplete the Ozone Layer -entry into force in 1st January 1989 (The Montreal Protocol On Substances that deplete the Ozone Layer 2003). Countries that ratify these conventions are bound by their operational and legal requirements and develop their own national legislation to support the convention. For example, the Montreal Protocol controls the production and consumption of substances that may cause ozone depletion, including chlorofluorocarbons, halons, carbon tetrachloride and methyl chloroform (The Montreal Protocol On Substances that deplete the Ozone Layer 2003). The United States enforced amendments to the Clean Air Act in 1990 to ensure that total phase out of these substances occur by 1996 (Oberthür 1999). The aim of the Basel Convention was to regulate the "transboundary movement of hazardous waste in order to prevent (or at the least limit) environmentally unsound management of wastes" (Tladi 2000, p.203). In response, Africa adopted the Bamako Convention on the Ban of the Import of Hazardous Wastes into Africa and on the Control of their

Transboundary Movements within Africa in 1998 (Tladi 2000). The Bamako Convention was developed due to the "perceived inadequacies of the Basel Convention in relation to developing countries, in particular the absence of a total ban on the export of hazardous and other wastes to African and other developing countries" (Naldi 2000, p.223). Shrivastava (1995) states that these conventions change world economics and further sharpen global competition.

South Africa has developed its own set of environmental legislation in response to this international pressure (Rawicz 1994). South Africa's ratification of the Basel Convention and the Montreal Protocol has encouraged the government to develop appropriate legislation to promote sustainability. In response to the Basel and Bamako Conventions, for example, the Department of Water Affairs and Forestry produced the Waste Management Series that establishes a reference framework of standards for waste management in South Africa (Republic of South Africa, Department of Water Affairs and Forestry. 2001. Waste Management Series. Minimum Requirements for Waste Disposal, Hazardous Waste Management and Monitoring).

Currently, legislation in South Africa is developed at three levels: national, regional and local. In support of the first principle of the Rio Declaration on Environment and Development, the Constitution of the Republic of South Africa Second Amendment Act No. 21 of 2002 contains an environmental right in Section 24 that states the following (South African Government 2003):

> Everyone has the right –
>
> (a) to an environment that is not harmful to their health or well-being; and
> (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –
>   (i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

All laws and practices must be tested against and administered in terms of the general standards contained in the Constitution of the Republic of South Africa Second Amendment Act No. 21 of 2002 and the standards promulgated in terms of the Environment Conservation Act 73 of 1989 and the National Environmental Management Act 107 of 1998 (South African Government 2003). Loots (1994) and Olver (2003; cited by Paton 2003) argue that, although South Africa has a considerable body of environmental legislation, it has not been and is not enforced effectively.

Authors argue that environmental regulation may be a third pathway leading to competitive advantage for a firm. Porter and van der Linde (1995a) state that business and governments have only focused on the cost of environmental regulation and have ignored the competitive benefit derived from it, namely the pressure on firms to innovate. Innovation in products due to regulation may produce "safer products, lower production costs, products with a higher resale or scrap value and lower disposal costs" (Porter and van der Linde 1995b, p.101). Innovation in processes due to regulation may produce "higher process yields, less downtime due to careful monitoring, material savings, utilization of by-products, lower energy consumption, reduced material storage and handling costs and the conversion of waste into useable form" (Porter and van der Linde 1995b, p.101).

Regulation may lead to competitive advantage not only through innovation but also by creating a barrier to entry in the market. When firms are proactive and move ahead of legislation and create partnerships with governmental bodies and policy makers in the development of legislation, they establish the industry standard and create a potential barrier to the market (Klassen and McLaughlin 1996).

2.4 Environmental Business Risk

Environmental business risk is another consideration for firms. Environmental business risk involves the legal costs and loss of income associated with environmental accidents, lawsuits, consumer boycotts and company closure. At a more specific level it involves oil and hazardous chemical spills, the production and use of harmful products, transportation accidents, waste disposal and workers' health (Anderson 1999). Not only is the lack of environmental management becoming a barrier to market entry, but companies that do not manage their environmental risk are being penalised financially and in the extreme case, being closed down.

South African-based firms that have ignored regulation and exposed themselves to environmental risk have faced the consequences. Polifin, a chemical gas manufacturer in Umbogintwini Amanzimtoti, caused chlorine gas leaks that affected several people in the vicinity (Department of Environmental Affairs and Tourism 2003). They did not meet with the standards of the Atmospheric Pollution Prevention Act 45 of 1965 and section 30 of the National Environmental Management Act of 1998 and as a result the Minister of Environmental Affairs and Tourism withdrew their registration certificate. Consequently, the plant closed down. Other examples are the company Woodcarb (Pty.) Limited which was forced to terminate the operation of its wood chip burner since it created large amounts of smoke and fly-ash and thereby infringed the rights of landowners living in the surroundings (South African Law Reports). And in March 1996 the company Village Drums and Pails was found guilty of having illegally erected an incinerator on their premises for the purpose of burning second-hand drums that released noxious and offensive gases. The company was prohibited from operating the incinerator and had to pay the legal fees of the case (South African Law Reports). The British-owned mining company operating in South Africa, Cape PLC, paid out approximately R97 million to 7 500 South African victims of asbestos-related diseases on the 13th March 2003 (SABC News 2003). And in March 2003, the Deputy Minister of Environmental Affairs and Tourism handed a R60 million directive to the company Guernica Chemicals to clean up, decontaminate and remove waste at Guernica, which was a result of operations that occurred in the 1960's (Department of Water Affairs and Forestry 2003).

Reinhardt (1999, p.150) argues that "managers should make environmental investments for the same reasons they make other investments: either because they expect them to deliver positive returns or to reduce business risk".

2.5 Environmental Management Practice in South Africa

Internationally, the environment is a powerful market force and this must be recognised by South Africa if it hopes to participate significantly in the world market (Skivington 1994). Newton-King (2003; cited by Botha 2003, p.71), the deputy chief executive officer of the Johannesburg Securities Stock Exchange, states that "international investors are seeking out companies with good sustainability records". Fields (2002) confirms this statement by saying that companies that publish sustainability reports are mining the opportunity to present themselves as leadership companies.

It follows that environmental management and consequent sustainability reporting is fast becoming prerequisites for sustainable business practice and international competitiveness. Several international authors have indicated that environmental management may even lead to competitive advantage and profitability for the firm. But what is the current environmental business practice in South African-based firms?

A study conducted in the South African food, textile and chemical industries in 1998 indicates that firms in these sectors do not appreciate the significance of their impact on the environment and that environmental issues are not factored into their strategic decision-making (Patel and Peart 1998). Also, few companies in South Africa measure the costs and benefits of social or environmental investment and as a result, annual reports that disclose information on the triple bottom line are few. In 1998 only twenty-three per cent of listed South African companies gave information on their environmental performance (Visser 1998) - this increased to fifty percent in 2002 (Naidoo 2002). However, only twenty-five percent of these companies disclosed financial management issues in their non-financial reports (Naidoo 2002). In South Africa, the general perception is that environmental management is difficult to implement and only costs money and therefore holds no financial benefit for the company (Visser 1998). This is supported by the fact that only slightly more than fifty per cent of listed companies in South Africa have an environmental policy or an environmental management system and even fewer are striving for compliance with any recognized voluntary environmental standard or conducting independent environmental audits (Visser 1998).

In 2003 the Department of Trade and Industry conducted a study to profile and benchmark the South African environmental industry and identify strategies to increase its international competitiveness (The Need for a South African Environmental Goods and Services Industry – First Draft Discussion Document 2003). South Africa was rated thirty-seventh out of forty-seven countries with regard to overall country competitiveness. It was found that the following constraints in the South African environmental sector have direct consequences for sustainable development in the country.

Firstly, South Africa lacks highly skilled professionals with the ability to redesign industrial processes in order to reduce waste and pollution and increase efficiency, thus incurring savings and improving bottom lines. Secondly, there is a lack of educated and experienced officials at the local government level that can create world-class legislation, enforce compliance with legislation and understand the relationship between environmental issues and the triple bottom line. And thirdly, South Africa does not own the consumer commitment necessary to create a healthy environment.

2.6 Parameters of Environmental Management and Profitability

Considerable research has been conducted internationally to suggest that environmental management can and does lead to competitive advantage for the firm. Andersen (1999, p.58) states it succinctly: "environmental management is seen as adding value, creating a competitive advantage, improving community image, reducing costs and enhancing the bottom line". Currently, however, no empirical research exists to indicate that this is true for South African-based firms.

The first step of this research was therefore to define the concepts environmental management and profitability in order to measure them quantitatively. Various definitions of the terms exist in industry and literature and it was thus required to operationalise the terms to allow the concepts to be defined clearly.

2.6.1 Parameters of environmental management

Banerjee and Iyer (2003, p.13) note that "developing appropriate indicators of environmental performance remains a challenging task for researchers". This is evident from the wide range of definitions of environmental management given in the literature; a summary of the referenced studies is given in Table 1.

Simmons (1981) stated that environmental management is the optimum use of natural resources without abusing or contaminating the earth's ecosystem. Sarkis and

Rasheed (1995) defined environmental management as pollution prevention[1] and later that year Porter and van der Linde (1995a) introduced the concept of resource productivity within a firm and innovation in response to environmental regulation. Shrivastava (1995) highlighted the role environmental regulation plays in shaping a firm's choice of process technology and its decision to implement environmental management. Klassen and McLaughlin (1996) viewed environmental management as the minimisation of a product's impact on the environment throughout the product life-cycle. Dechant and Altman (1994) included a firm's development of environmentally-focused partnerships and environmental education in the definition of environmental management.

Hart (1997) recommended three environmental strategies a firm should follow to move towards sustainability and introduced the tool Design for the Environment which is used to design products that are easier to recover, reuse and recycle. The resource-based view of Russo and Fouts (1997) highlighted the role environmental policy plays in the implementation of environmental management strategies. They divided a firm's resources into three categories, namely tangible, intangible and personnel-based and stated that environmental policy can move a firm from a strategy of legal compliance to a strategy of pollution prevention. For many businesspeople, environmental management means risk management (Reinhardt 1999). Their primary objective is to avoid the costs that are associated with an industrial accident, a consumer boycott or an environmental lawsuit. Finally, Banerjee and Iyer (2003, p.50) coined the phrase corporate environmentalism to describe the strategic implementation of environmental management within a firm.

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[1] The SABS ISO 14001:1996(E) Environmental Management Standard defines pollution prevention as follows: the use of processes, practices, materials or products that avoid, reduce or control pollution, which may include recycling, treatment, process changes, control mechanisms, efficient use of resources and material substitution.

Table 1 Parameters of Environmental Management

Parameter	**Author**
• The purpose of environmental management is to produce resources, but simultaneously to retain a life-supporting environment. It is therefore an attempt to reconcile the demands of socio-economic systems with the constraints of the biosphere. • Environmental management is an attempt to optimize yields from a particular resource process by exerting governmental control or influence upon part of the resource process. • Environmental management aims to reduce stress on ecosystems from contamination or over-use: no resource process should be developed which bring about irreversible environmental change. • As a set of values, environmental management is ambivalent towards economic growth. It recognizes that there is an absolute limit to the materials and surface of the planet but sees no reason to prevent the use of the resources up to that limit, provided that some ecological stability can be maintained, whether by preserving the natural systems or by increasing man-directed inputs of energy, matter and information.	Simmons (1981)
• Best practices of environmental leadership: 1. A mission statement and corporate values that promote environmental advocacy. 2. A framework or program for managing environmental initiatives within the company. 3. Green process and product design, including life cycle analysis. 4. Environmentally-focussed stakeholder partnerships. 5. Internal and external education initiatives.	Dechant and Altman (1994)
• Being environmentally conscious involves detailed attention to a variety of issues, such as energy conservation, pollution prevention and avoidance of ecological degradation.	Sarkis and Rasheed (1995)
• Environmental improvement efforts have traditionally focused on pollution control through better identification, processing and disposal of discharges or waste – costly approaches. • In recent years, more advanced companies and regulators have	Porter and van der Linde (1995)

embraced the concept of pollution prevention, sometimes called source reduction, which uses closed-loop processes to limit pollution before it occurs.	
• Pollution often reveals flaws in the product design or production process. Efforts to eliminate pollution can therefore follow the same basic principles widely used in quality programs: use inputs more efficiently, eliminate the need for hazardous, hard-to-handle materials and eliminate unneeded activities. • Innovation in response to environmental regulation can take two broad forms. The first is that companies simply get smarter about how to deal with pollution once it occurs, including the processing of toxic materials and emissions, how to reduce the amount of toxic or harmful material generated and how to improve secondary treatment. The second form of innovation addresses environmental impacts while simultaneously improving the affected product itself or / and related processes.	Porter and van der Linde (1995)
• Sustainability means meeting our current needs without jeopardizing the ability of future generations to meet theirs. It involves pacing the use of resources so that they can be renewed and maintained within a natural equilibrium. • Environmental regulations influence competitive behaviour of firms and the competitive dynamics of industries by imposing new costs, investment demands and opportunities for improving production and energy efficiency. • Environmental regulations and costs are already shaping strategic decisions about sourcing raw materials, locating production facilities, managing energy and wastes, in environmentally sensitive industries such as chemicals, oil, forest products, metals and mining. • One strategic variable that fundamentally changes environmental impacts, risks and costs of companies is the choice of technologies. • Product and production technologies determine the basic parameters of costs and ecological impacts. They determine the type of raw materials that can be used, production efficiencies, pollution emitted from production processes, worker health and safety, public safety and management of wastes.	Shrivastava (1995)

• Environmental management encompasses all efforts to minimize the negative environmental impact of the firm's products throughout their life cycle. • Environmental management affects both structural and infrastructural components as it involves choices of product and process technology and underlying management systems. • Product technology includes the use of recycled raw materials or post-consumer recycling. • Process technology includes more efficient production systems, end-of-pipe control technology and preventative barriers. • Management systems encompass programs such as continuous monitoring of any process discharges, worker training and environmental audits. • Observed effects of environmental performance include: explicit consideration of environmental issues in product and process design, environmental responsibility at a senior level, formal, structured reporting systems to monitor and improve environmental performance, participative programs with customers, government and third parties.	Klassen and McLaughlin (1996)
• Three environmental strategies are required to move a company towards sustainability. Strategy One is Pollution Prevention, which depends on continuous improvement efforts to reduce waste and energy use. Strategy Two is Product Stewardship which focuses on all the environmental impacts associated with the full life cycle of a product. Included is Design for the Environment – a tool for creating products that are easier to recover, reuse, or recycle. Strategy Three is Clean Technology which is the use of technology to promote environmental sustainability.	Hart (1997)
• Environmental policy plays a role in generating broader organizational advantages that allow a firm to capture premium profits. In the resource-based view, resources are classified as tangible, intangible and personnel-based. Tangible resources include financial reserves and physical resources such as plant, equipment and stocks of raw materials. Intangible resources include reputation, technology and human resources; the latter include culture, the training and expertise of employees and their commitment and loyalty. As these resources are	Russo and Fouts (1997)

not productive on their own, the analysis also needs to consider a firm's organizational capabilities – its abilities to assemble, integrate and manage these bundles of resources. • Two modes of environmental policy in developing their theory. The first is the compliance strategy, wherein firms rely on pollution abatement through short-term, "end-of-pipe" approach, often resisting the enactment and enforcement of environmental legislation. Firms often fall short of compliance in this mode. • The second mode of environmental policy is going beyond compliance to a focus on prevention, a systematic approach that emphasizes source reduction and process innovation. They argue that firms that tend toward the compliance mode will differ in their resource bases from those that tend towards prevention and that this policy choice will affect firms' ability to generate profits. • The resources and capabilities required to implement a firm's environmental policy vary radically, depending on whether or not that firm goes beyond compliance to embrace pollution prevention. End-of-pipe compliance policies affect only physical asset resources, which consist of the physical technology used in the firm, a firm's plant and equipment, its geographical location and its access to raw materials. Compliance is achieved primarily by the addition of pollution-removing or filtering devices to the existing assets of a firm and does not require the firm to develop expertise or skills in managing new environmental technologies or processes. The technology is essentially self-contained, off-the-shelf hardware. Once such hardware is installed, it does not fundamentally vary production or service delivery processes.	Russo and Fouts (1997)
• For many businesspeople, environmental management means risk management. Their primary objective is to avoid the costs that are associated with an industrial accident, a consumer boycott or an environmental lawsuit. • Three conditions are required for success with environmental product differentiation. First, the company has identified customers who are willing to pay more for an environmentally friendly product. Second, it has been able to communicate its product's environmental benefits credibly. And third, it has been able to protect itself from imitators for	Reinhardt (1999)

long enough to profit on its investment.	
• Corporate environmentalism is the recognition of the importance of environmental issues facing the firm and the integration of those issues into the firm's strategic plans.	Banerjee and Iyer (2003)

2.6.2 Parameters of profitability

In search for the definitions of the concept profitability, both accounting and economic literature was studied. Accounting literature presents the historic and current indicators used by industry to report profitability: return on assets, return on investment, return on equity, return on capital employed, gross profit margin and profit margin on sales (Aupperle, Carroll and Hatfield 1985; Klassen and McLaughlin 1996; Piasecki, Fletcher and Mendelson 1995; Russo and Fouts 1997).

Aupperle, Carroll and Hatfield (1985, p.446) state that "the problem in assessing levels of corporate social responsibility is objectively determining appropriate criteria and standards of corporate performance ". They quote Parket and Eilbirt (1975, p.6):

> To be sure, the scope of endeavour categorized by the term **social responsibility cannot be analysed on the order of a balance sheet or profit and loss statement**. There are, as yet, no accounting techniques, analytical tools or statistical methods which will objectively differentiate companies that are socially responsible from those that are not.

The first change to this perception occurred when Elkington (2002; cited by Fields 2002) introduced the triple bottom line to the business world. The triple bottom line is a measure of a firm's financial performance based on three criteria: social, economic and environmental performance. Therefore, it is now possible and even required of firms to measure their environmental performance in financial terms and one of the tools that make this possible is the application of transaction costs in environmental economic analysis. In his article "The Nature of the Firm" written in 1937, Ronald Coase introduced the term transaction costs to include the full opportunity cost within a transaction (Coase 1998). He highlights the importance of transaction costs in the following statement (Coase 1988; cited by Wang 2003, p.1):

> Without the concept of transaction costs, which is largely absent from current economic theory, it is my contention that it is impossible to understand the working of the economic system, to analyse many of its problems in a useful way, or to have a basis for determining policy.

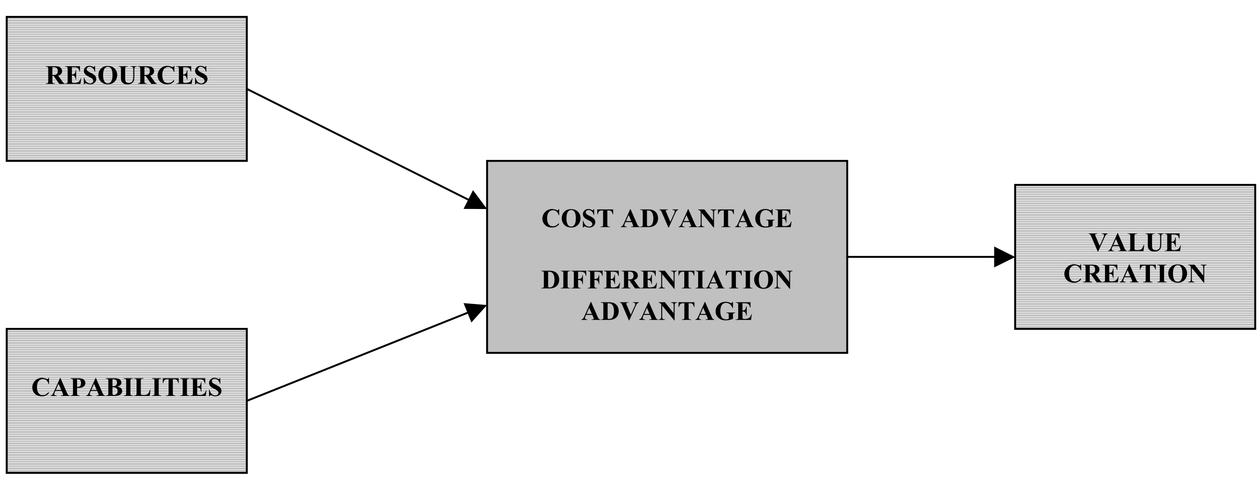
Benham and Benham (2001) define opportunity costs as the costs of exchange in total resources – money, time and goods – for an individual to obtain a certain good in a certain institutional setting. It includes the price of the good itself plus the transaction costs of obtaining the good. "For a given good, these costs will be affected by the specific characteristics of the individual, the type of exchange, and the institutional setting within which the individual is operating. Across individuals, across markets, and across countries, therefore, the costs are likely to vary greatly" (Benham and Benham 2001, p.1). Porter and van der Linde (1995a) state that companies tend to focus only on the obvious costs of eliminating or treating pollution without including the opportunity costs of wasted resources, wasted effort and reduced product value. Wang (2003) gives several examples of the application of transaction costs in environmental economics in the United States of America. One such example is the study of water transfer from agriculture to other uses by Colby (1990; cited by Wang 2003). In this study the transaction costs include attorneys' fees, engineering and hydrological studies, courts costs and fees paid to the state agencies. Another example is the study of pollution control programs by McCann, Easter and Easter (1999; cited by Wang 2003) in which the transaction costs include the costs of information collection and analysis, enactment of legislation, design and implementation of policies, continuous support and administration of the programs, monitoring and detection, labour input and persecution. These studies show that it is possible to measure the financial performance of a firm's environmental endeavours.

Consideration of both accounting theory and economic theory led to the development of three dimensions for the concept profitability, namely: competitive advantage, intellectual capital and return on investment. Return-on-assets and return-on-equity were used as measures of a firm's financial performance in two separate empirical studies of the literature study, Russo and Fouts (1997) used return-on-assets as a measure of firm performance and Klassen and McLaughlin (1996) employed return-on-equity, arguing that the market's assessment of the firm value and its expected performance are reflected in this value. This study supports the view of Piasecki *et al*. (1995) who state that return on investment is still the most common business test of validity.

Competitive advantage

In strategy literature Porter (Quick MBA Strategic Management 2003) provides a model for gaining competitive advantage in Figure 1.

Figure 1 Porter's model of competitive advantage



He proposes that a firm can utilize its' resources and capabilities to gain competitive advantage via two routes: the cost advantage or the differentiation advantage. Applied to environmental management strategy, this implies that companies can command higher prices for environmentally-friendly products or enter new markets with these products (competitive advantage by differentiation). A firm's capabilities would then include rapid innovation, the ownership of intellectual capital in product and process design and management capability. Also, the company creates a reputation of being environmentally conscious and this in itself is a form of competitive advantage and a source of revenue (Klassen and McLaughlin 1996; Porter and van der Linde 1995a; Shrivastava 1995; Russo and Fouts 1997). Furthermore, rapid innovation and the ownership of patents and knowledge may create a barrier-to-market entry for rival firms: another source of competitive advantage (Porter and van der Linde, 1995a).

Intellectual capital

Stewart (2001, p.12) defines intellectual capital as "knowledge that transforms raw materials and makes them more valuable". He states that intellectual capital is derived from three components: human capital (the skills and knowledge of people), structural capital (patents, processes, databases and networks) and customer capital (relationships with customers and suppliers). Stewart (2001, p.13) proposed the Intellectual Capital Model which illustrates that the total market value of a firm is composed of tangible assets and intangible assets. The model is presented in figure 2.

Figure 2 Stewart's model of intellectual capital (Stewart 2001, p.13)

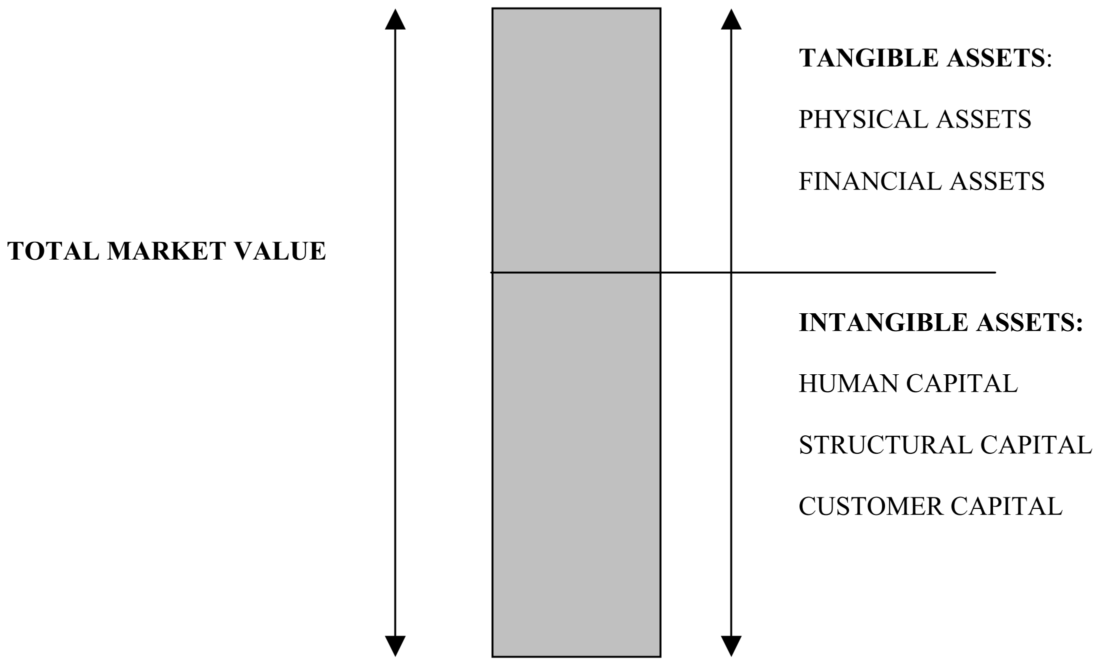


Table 2 provides a detailed summary of the strategy literature of competitive advantage and intellectual capital.

Table 2 Parameters of Profitability

Parameters	**Author**
• Return on investment is still the most common business test of validity.	Piasecki, Fletcher and Mendelson (1995)
• Competitive advantage accrues directly from cost reductions and revenue improvements prompted by environmental technologies.	Shrivastava (1995)

• Many companies are using innovations to command price premiums for "green" products and to open up new market segments. • The new paradigm of global competitiveness requires the ability to innovate rapidly. • Competitiveness at industry level arises from superior productivity, either in terms of lower costs than rivals or the ability to offer products with superior value that justify a premium price.	Porter and van der Linde (1995)
• The financial performance of a firm is affected by strong environmental performance through both revenue and cost pathways. • Because environmental requirements are often based on best available technology, an industry leader could gain competitive advantage by establishing the industry standard and creating a potential barrier to entry.	Klassen and McLaughlin (1996)
• In resource-based theory, competitive advantage is rooted inside the firm, in assets that are valuable and inimitable. Tangible resources include financial reserves and physical resources such as plant, equipment and raw materials. Intangible resources include reputation, technology and human resources; the latter includes culture, the training and expertise of employees and their commitment and loyalty. A firm's capabilities or competencies and management's ability to marshal these assets to produce superior performance determine competitive advantage.	Russo and Fouts (1997)
• A competitive advantage exists when the firm is able to deliver the same benefits as competitors but at a lower cost (cost advantage) or deliver benefits that exceed those of competing products (differentiation advantage).	Porter (2003) Quick MBA Strategic Management
• A resource-based view emphasizes that a firm utilizes its resources and capabilities to create a competitive advantage that ultimately results in superior value creation. • Resources are the firm-specific assets useful for creating a cost or differentiation advantage and that few competitors can acquire easily, for example, patents and trademarks, an installed customer base, reputation of the firm and brand equity.	Porter (2003) Quick MBA Strategic Management

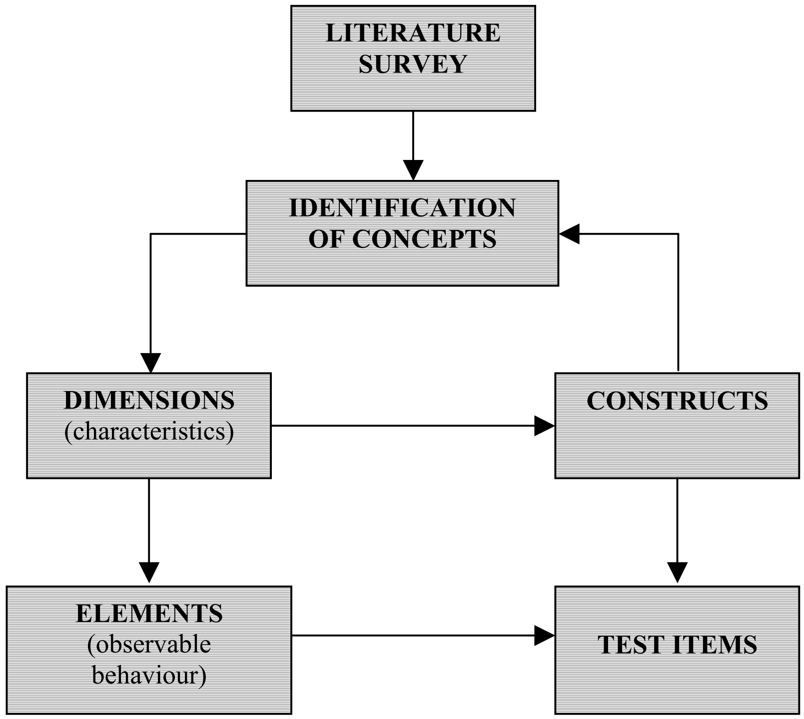
• Capabilities refer to the firm's ability to utilize its resources effectively.	
• From a strategic perspective, barriers-to-entry can be created or exploited to enhance a firm's competitive advantage. Barriers reduce the rate of entry of new firms, thus maintaining a level of profits for those already in the industry. • Barriers-to-entry arise from several sources, namely government regulation, patents and proprietary knowledge, asset specificity (the extent to which the firm's assets can be utilized to product a different product) and internal economies of scale.	Porter (2003) Quick MBA Strategic Management
• Intellectual capital is knowledge that transforms raw materials and makes them more valuable: human capital (the skills and knowledge of people), structural capital (patents, processes, databases and networks) and customer capital (relationships with customers and suppliers).	Stewart (2001)

2.7 Operationalisation of Environmental Management and Profitability

One of the biggest challenges of this research study was to develop a set of measures for the concepts Environmental Management and Profitability. The method used to operationally define the concepts was one suggested by Sekaran (1992, p.157). The method requires the definition of dimensions (characteristics) and elements (observable behaviours) for each concept from the literature study. The dimensions then form the constructs of the concept and the elements are developed into the items that test the concept quantitatively. The process is illustrated in Figure 3.

Firstly, the definitions provided by the literature study were used to extract six dimensions of the concept Environmental Management (EM). These are construct 1 Top Management Commitment (TMC), construct 2 Product and Process Technology (PPT), construct 3 Risk Management (RM), construct 4 Stakeholder Partnerships (STP), construct 5 Resource Conservation (RC) and construct 6 Employee Relations (ER).

Figure 3 Identification of constructs and test items



Each dimension was analysed to identify the corresponding observable behaviour – or elements - within a firm. The elements were then used to develop the test items for each construct. The dimensions and corresponding elements for Environmental Management are given in Table 3.

The number of test items developed for construct 1 Top Management Commitment was twelve; for construct 2 Product and Process Technology seven test items; for construct 3 Risk Management five test items; for construct 4 Stakeholder Partnerships seven test items; for construct 5 Resource Conservation four test items and for construct six Employee Relations six test items.

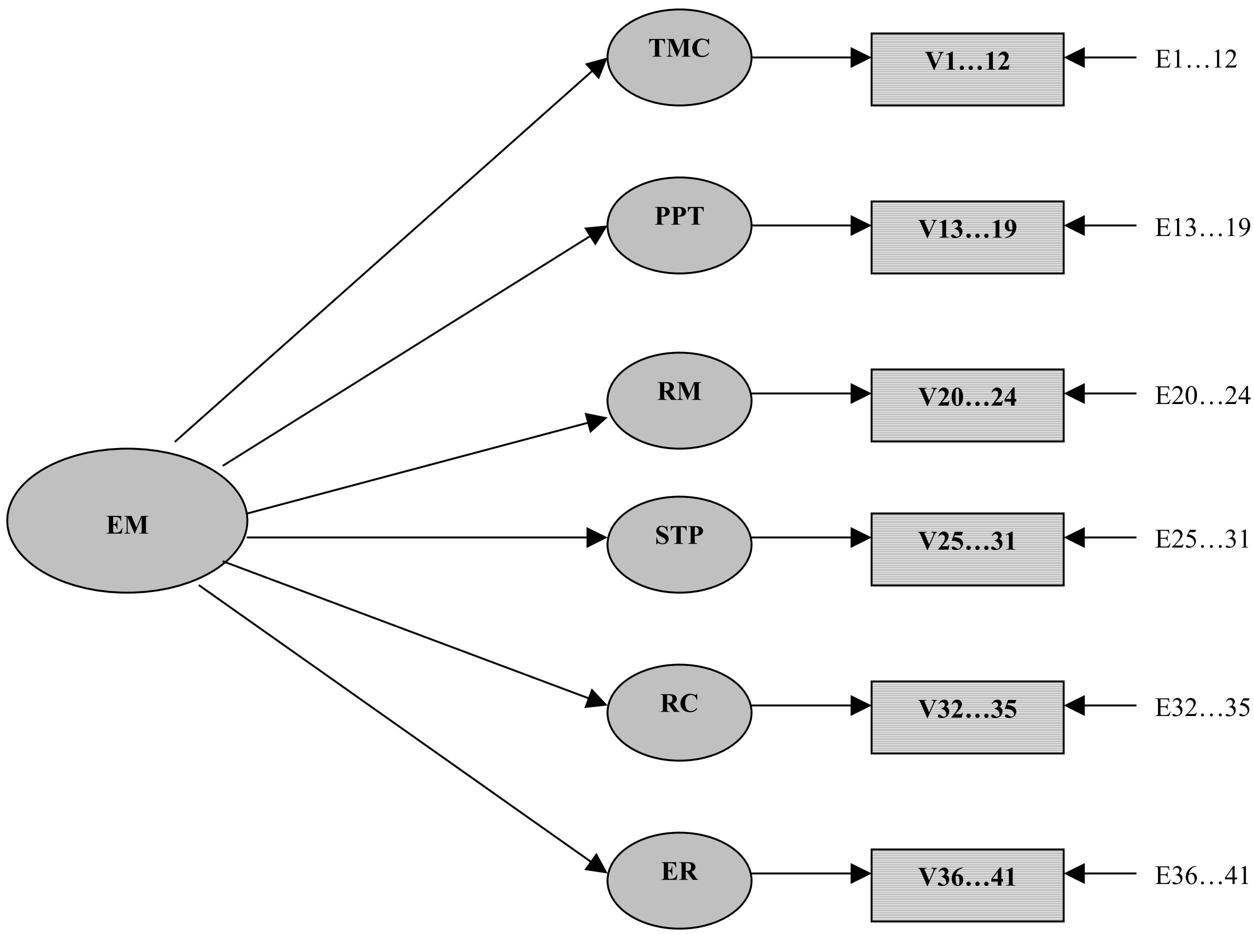
Table 3 Dimensions and elements of Environmental Management

	ELEMENT
CONSTRUCT 1: TOP MANAGEMENT COMMITMENT	• Top management drives and supports environmental initiatives. • The company has an environmental mission statement. • Incorporates environmental management into strategic business plans. • Budgets for environmental initiatives. • Implements environmental programs and plans to minimize pollution and improve resource conservation. • Develops and implements objectives for continuous environmental improvement. • Measures and monitor environmental performance. • Reports on environmental performance in annual reports. • Conducts internal environmental audits. • Conducts external, independent audits.
CONSTRUCT 2: PRODUCT AND PROCESS TECHNOLOGY	• Recycles raw materials. • Recycles post-consumer product waste. • Designs new products to minimize or prevent environmental impact. • Applies preventative measures such as life-cycle analysis. • Investigates and changes the current production system to reduce or eliminate pollution. • Treats air emissions, effluents and waste before discharge. • Implements end-of-pipe technology to reduce or eliminate pollution. • Measures and monitors the quantity and quality of air emissions, effluents and waste.
CONSTRUCT 3: RISK MANAGEMENT	• Complies with environmental legislation to avoid costs associated with industrial accidents, lawsuits, consumer boycotts and company closure. • Engages in environmental lawsuits. • Changes production process or product to comply with environmental legislation.

CONSTRUCT 4: STAKEHOLDER PARTNERSHIPS	• Develops partnerships with environmentally-conscious suppliers. • Influences and promotes the implementation of environmental programs at suppliers. • Actively engages with government to develop and implement environmental legislation. • Actively engages in environmental partnerships with community. • Conducts environmental impact assessments before construction that may affect the environmental. • Actively promotes environmental conservation (or contributes financially). • Creates external environmental awareness by communicating with stakeholders and community (e.g. teaching at schools). • Conducts market research to determine consumer needs for environmentally-friendly products. • Develops marketing strategies that promotes environmental awareness. • Emphasizes the environmental aspects of products and services in advertisements. • Promotes the company's image as "green". • Complies with environmental legislation to ensure international trading.
CONSTRUCT 5: RESOURCE CONSERVATION	• Measures and monitors the consumption of resources, including water, energy and land. • Clearly indicates resource consumption in financial terms. • Communicates the consumption resources with stakeholders, including the public, shareholders and communities. • Implements programs to minimize the consumption of resources. • Promotes internal environmental awareness by training employees. • Considers environmental preservation as a core value of the firm. • Communicates the consumption of resources with employees.
CONSTRUCT 6: EMPLOYEE RELATIONS	• Appoints personnel specifically for environmental issues. • Rewards employees for environmental performance.

The framework for the dimensions and elements is illustrated in Figure 4.

Figure 4 Framework for the dimensions of Environmental Management



The same methodology was followed to develop the dimensions and elements for the concept Profitability. Firstly, profitability (PROFIT) was delineated into three dimensions: construct 7 Return-on-Investment (ROI), construct 8 Intellectual Capital (IC) and construct 9 Competitive Advantage (CA).

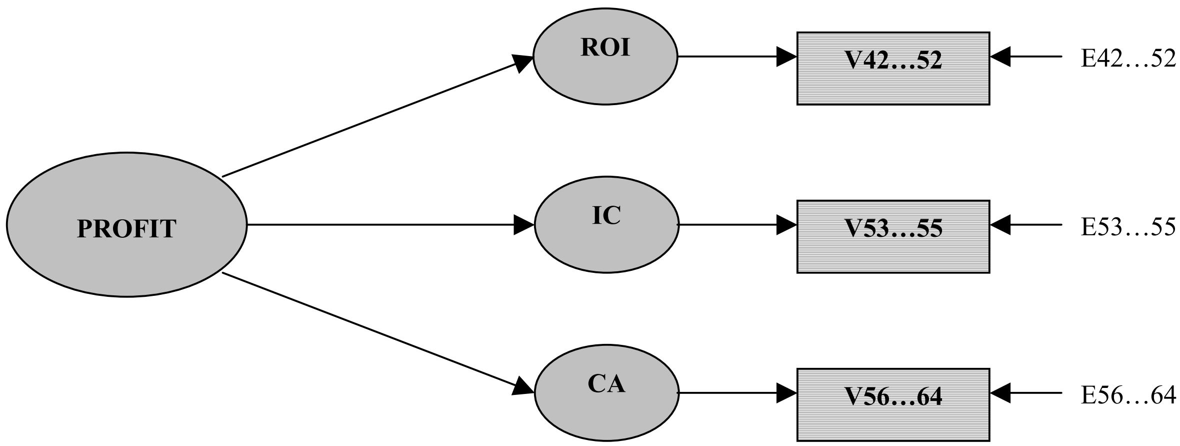
The elements for each dimension were identified from Table 2 and then the test items were developed for each construct. Eleven test items were developed for construct 7 Return-on-Investment; three test items for construct 8 Intellectual Capital and nine test items for construct 9 Competitive Advantage. The dimensions and elements of Profitability are given in Table 4.

Table 4 Dimensions and elements of Profitability

	ELEMENT
CONSTRUCT 7: RETURN ON INVESTMENT	• Return on investment (ROI) which is calculated by dividing earnings by total assets.
CONSTRUCT 8: INTELLECTUAL CAPITAL	• Training and expertise. • Loyalty and commitment. • The firm's ability to utilize its resources effectively.
CONSTRUCT 9: COMPETITIVE ADVANTAGE	• Delivers the same benefits as competitors but at a lower cost. • Delivers benefits that exceed those of competing products (enhanced product or service value). • Governmental regulation. • Develops patents that restrict market entry. • Asset specificity: the extent to which the firm's assets can be utilized to produce a different product. • Internal economies of scale. • Brand identity and company reputation (corporate image). • Existing customer base and supplier relationships. • Technology.

The framework for the concept Profitability is illustrated in Figure 5.

Figure 5 Framework for the dimensions of Profitability



The research instrument thus consisted of nine constructs measured by sixty-four test items. Six test items were included to obtain demographic information about the participant. The research instrument is given in Appendix A.

2.8 Research Questions and Objectives

The literature survey indicates that environmental management promotes a firm's competitive advantage and increases its profitability. Currently, however, no empirical research exists to indicate that this is true for South African-based firms. This lack of information led the researcher to ask the following question:

> **Does environmental management increase a South African-based firm's profitability?**

As a result, the concepts Environmental Management and Profitability were delineated to obtain dimensions and elements for the concepts and thus allow them to be measured quantitatively.

At the first South African conference on Environmental Management, Technology and Development, Rawicz (1994) stated that the following driving forces cause firms to develop and implement environmental management:

1. To comply with legislation and regulations and comply with waste and pollution minimization standards;
2. To satisfy growing public pressure and social demands;
3. To meet new market demands;
4. To minimize risk and liability exposure;
5. To meet the requirements of international trading partners;
6. To meet the requirements of international treaties and conventions.

The second research question was developed from this publication, namely:

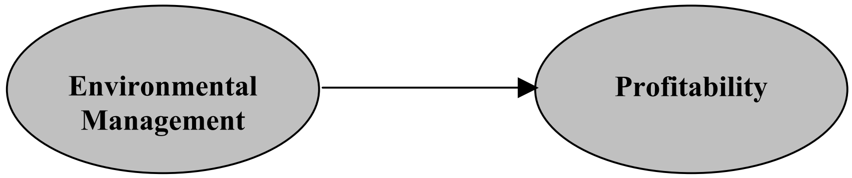
What are the key factors that influence a South African-based firm's decision to implement environmental management strategies?

The research objectives then followed from the research questions - these are listed below:

1. To develop measures for the concepts Environmental Management and Profitability.
2. To determine whether there is a positive causal relationship between environmental management and profitability in South African-based firms.
3. To determine the key factors which influence a South African-based firm's decision to implement environmental management.

The causal relationship between Environmental Management and Profitability is proposed in Figure 6. The figure indicates that environmental management has a positive, causal effect on profitability.

Figure 6 Proposed relationship between Environmental Management and Profitability



Thus, the primary research objective of this paper is:

To determine whether there is a positive relationship between environmental management and profitability in South African-based firms.

The secondary research objective is:

To determine the key factors that cause South African-based firms to implement environmental management.

3. RESEARCH DESIGN AND METHODOLOGY

3.1 Research Strategy

A deductive research strategy was applied since there is a search to explain the causal relationships between variables. The researcher used the methodology of deductive research recommended by Robson (1993; cited by Saunders, Lewis and Thornhill 2003, p.86) which lists five stages through which deductive research progresses. These steps are summarized below:

Step 1: A hypothesis is deduced from the literature survey.

Step 2: The hypothesis is operationalised to enable the variables to be measured quantitatively.

Step 3: The operational hypothesis is tested by a form of empirical inquiry.

Step 4: The outcome of the inquiry is examined with the application of statistical techniques.

Step 5: The theory is modified if necessary.

Saunders, Lewis and Thornhill (2003) state that several characteristics of deductive research are important to ensure scientific rigour. The first is that the research should use a highly structured methodology to facilitate replication of the research and thereby ensure reliability. The second is that the researcher must be independent of what is being observed and the questionnaire must be designed in such a way that it promotes the validity of the data collected. Thirdly, the theoretical concepts must be operationalised to ensure clarity of definition and enable the concepts to be measured quantitatively. Finally, the sample size must be large enough to ensure generalisation of the conclusions.

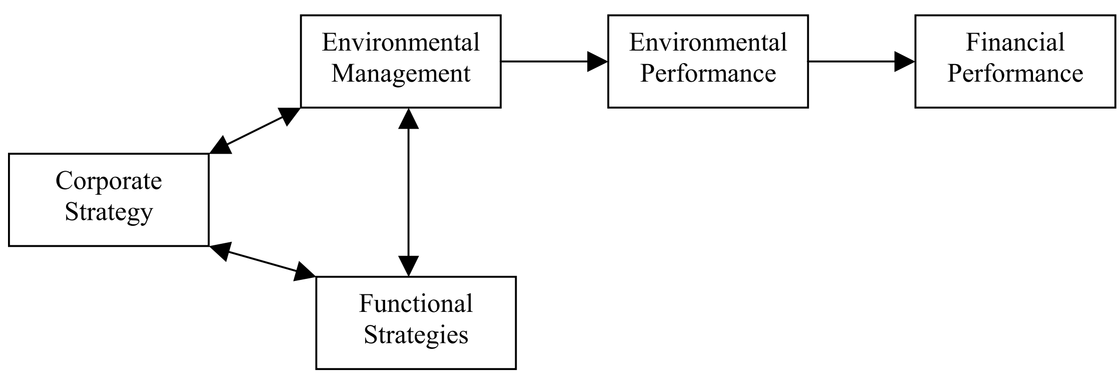
The application of these criteria in the research methodology is discussed in the following paragraphs.

3.2 Research Model and Hypotheses

3.2.1 Research model

Klassen and McLaughlin's (1996, p.1200) model of the link between strategy, environmental management and firm performance (Figure 7) was used as the starting point for the development of a theoretical model for this research.

Figure 7 Model of the link between strategy, environmental management and firm performance (Klassen and McLaughlin 1996, p.1200)



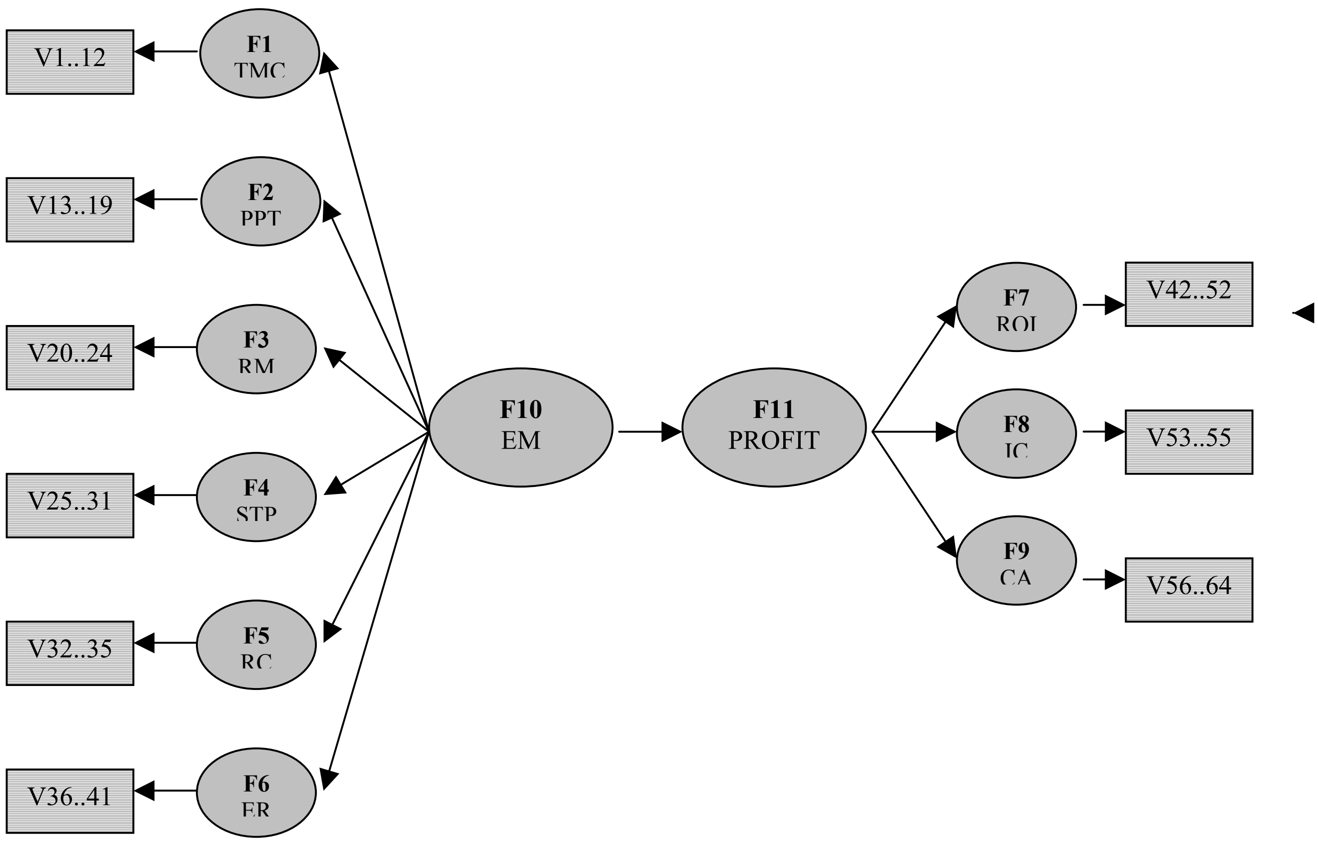
The model shows the links between corporate strategy, environmental management and firm performance. The researchers state that "corporate strategy determines the environmental orientation of the firm" (Klassen and McLaughlin 1996, p.2001). They propose that environmental management is an important component of operations management (functional strategies) and as such environmental management is defined by two underlying concepts: the choice of product and process technologies and the underlying management systems. Furthermore, the authors propose that strong environmental performance affects the financial performance of a firm through revenue and cost pathways. They measured strong environmental performance as a firm winning an environmental award and this award being announced by an independent third party. Financial performance was measured using the firm's return-on-equity and their choice of indicator was influenced by the fact the "new public information is continually assessed, valued, and reflected in the stock price" (Klassen and McLaughlin 1996, p.1204).

Although the previous authors' model was used a starting point for the development of the proposed research model in this study, it was found to be lacking in three areas: the delineation of the concept environmental management, the measurement of environmental performance and the choice of financial performance indicator. The literature study presented previously strongly indicates that the concept environmental management involves more than the choice of products and processes and environmental management systems. This study includes an additional five dimensions to describe environmental management within firms.

Secondly, using an environmental award as indicative of strong environmental performance would not be a reflection of strong environmental performance in South African-based firms since firms in this country do not compete for environmental awards.

Thirdly, the previous authors used only an accounting indicator to reflect profitability and it has been shown that profitability can be measured by non-accounting dimensions such as intellectual capital and competitive advantage. As such, the current proposed model includes six dimensions for environmental management and three dimensions for profitability. The full hypothesized structural equation model is given in Figure 8.

Figure 8 Proposed model for the link between Environmental Management and Profitability



The above-model proposes that Environmental Management is defined by six constructs: Top Management Commitment, Product and Process Technology, Risk Management, Resource Conservation, Stakeholder Partnerships and Employee Relations.

Three constructs, namely Return on Investment, Intellectual Capital and Competitive Advantage define the latent verbal Profitability. Finally the model proposes a positive causal relationship between Environmental Management and Profitability.

3.2.2 Construct definition and hypotheses development

Construct 1 Top Management Commitment measures the extent to which top management recognizes the importance of environmental issues facing the firm and the integration of those issues into the firm's strategic and operational plans. The definition was adopted from the term Corporate Environmentalism introduced by Banerjee and Iyer (2003). Thus, the first research hypothesis proposed by the model is:

H1: Top Management Commitment is related to Environmental Management.

Construct 2 Product and Process Technology seeks to measure the extent to which a firm designs and manages its products, technology and operations in order to reduce the impact of its activities on the environment. Included in this definition are the possible application of (a) product life-cycle analysis and (2) end-of-pipe technology within the firm. Product life-cycle analysis or life cycle assessment studies the environmental aspects and potential impacts of a product throughout its life cycle from raw material acquisition to production, use and disposal. End-of-pipe technology is the addition of pollution-removing or filtering devices to the existing process; it can be bought off-the-shelf and is readily available to all firms. The second research hypothesis is proposed:

H2: Product and Process Technology is related to Environmental Management.

Construct 3 Risk Management seeks to measure the effect of environmental legislation on a firm's strategy and operations and the risk a firm faces as a result of a lack of environmental concern and non-compliance to legislation. These risks include industrial accidents, lawsuits, consumer boycotts and company closure. A boycott is defined as "the concerted (but non-mandatory) refusal by a group of consumers to do business with one or more companies for the purpose of expressing disapproval of certain policies, and attempting to coerce the companies to modify those policies" (Garrent 1991; cited by Schifmann and Kanuk 1991, p.636). This leads to the third research hypothesis:

H3: Risk Management is related to Environmental Management.

Freeman (1984; cited by Banerjee and Iyer 2003) defines environmental stakeholders as individuals or groups that can affect or be affected by the achievement of a firm's environmental goals. According to this definition the researcher defined the following groups as stakeholders: government, communities, suppliers and shareholders. Organizational members or employees were included in a separate construct. Construct 4 Stakeholder Partnerships therefore seeks to measure the extent to which a firm develops long-term relationships with its stakeholders.
Thus, the fourth research hypothesis is:

H4: Stakeholder partnerships is related to Environmental Management.

Construct 5 Resource Conservation measures two concepts. First is the use of natural resources by the firm during its activities – the use of water, energy and land during the manufacture of a product or the delivery of a service. Second is nature conservation or preservation, which includes wildlife protection, habitat protection and landscape protection. The construct therefore measures the extent to which (1) the firm uses natural resources (water, energy and land) and (2) contributes to nature conservation. The fifth research hypothesis is proposed as:

H5: Resource Conservation is related to Environmental Management.

Russo and Fouts (1997) identify personnel as one of the resources of a firm and define this resource as the culture, training and expertise of employees and their commitment and loyalty towards the firm. Construct 6 Employee Relations measures the extent to which employees remain committed to the firm by sharing with it the core value environmental management, the extent to which the firm contains environmental management skills and the extent to which employees are involved in environmental management within the firm. Thus, the following hypothesis is proposed:

H6: Employee Relations is related to Environmental Management.

Construct 7 Return on Investment measures the potential revenue gained from investment in environmental initiatives as well as the potential cost savings or cost minimization achieved. The researcher proposes the following hypothesis:

H7: Return on Investment is related to Profitability.

Construct 8 Intellectual Capital measures the potential innovation within the firm gained from compliance with environmental legislation, the patent and productivity benefits from process and product redesign and intellectual capital due to skills and knowledge of employees. Thus, the following research hypothesis is suggested:

H8: Intellectual capital is related to Profitability.

Porter (Quick MBA Strategic Management 2003) provides a framework for industry as being influenced by five forces: supplier power, threat of substitutes, degree of rivalry, buyer power and barriers to entry. From this analysis, Porter states that a firm can gain competitive advantage when it is able to deliver the same benefits as its competitors but at a lower cost (cost advantage) or deliver benefits that exceed those of competing products (differentiation advantage). Also, barriers-to-entry can be created or exploited to enhance a firm's competitive advantage. Porter defines a barrier-to-market entry as follows (Quick MBA Strategic Management 2003, p6):

> In theory, any firm should be able to enter and exit a market, and if free entry and exit exists, then profits always should be nominal. In reality, however, industries possess characteristics that protect the high profit levels in the market and inhibit additional rivals from entering the market.

Porter also gives the following examples of resources that are the firm-specific assets useful for creating a cost or differentiation advantage within a firm: patents and trademarks, an installed customer base, the reputation of the firm and brand equity. Several sources of barriers-to-entry include government regulation, patents and proprietary knowledge and asset specificity – the extent to which the firm's assets can be utilized to design and manufacture a different product.

From this analysis, Construct 9 Competitive Advantage was developed to measure the potential competitive advantage gained by an increase in market share, entry into new markets, creation of barriers-to-market entry, employee commitment, reduction in financial risk and long-term relationships with stakeholders – all potentially gained by the practice of environmental management. Thus, the following research hypothesis is proposed:

H9: Competitive Advantage is related to Profitability.

In addition, this paper investigates empirically the proposition that Environmental Management positively affects the Profitability of a firm. The final research hypothesis proposed by the model is:

H10: Environmental Management increases a firm's Profitability.

3.3 Research Questionnaire

3.3.1 Constraints during design of research questionnaire

This research study employed self-administered questionnaires that were delivered and returned electronically via email and the Internet. This type of administration was used because of a lack of financial resources which prevented postal administration of the questionnaires. As a result, the Internet was used to design and deliver the survey form.

The main financial resource implications of this method are the use of email and the Internet and the requirement of a web page design computer program. The use of the Internet did not present a financial constraint to the researcher. The researcher requested the assistance of her employer's web site designers with the web page design of the survey form and the hosting of the website. Due to time constraints and company policy, neither were possible. The researcher then obtained the web page design program Microsoft FrontPage version 2000 from the company library and designed the survey form with input from the project supervisor. Finally, the University of the Witwatersrand granted the researcher space on its' Sunsite website to host the survey form. Due to these constraints experienced during the web page design of the survey form, the administration of the research project was delayed by four weeks.

3.3.2 Attributes of the research questionnaire

The main attributes of a research questionnaire are given by Saunders *et al*. (2003, p.284) and were used to ensure that email and the Internet are the correct tools for administration of the questionnaire of this research study. Firstly, the respondents of the questionnaire were selected as the top to middle management of a firm and it was assumed that these individuals are computer-literate and can be contacted directly via email and the Internet. Secondly, confidence that the right person has responded to the questionnaire is relatively high with the use of email administration. Thirdly, online questionnaire administration favours a large sample size which is geographically dispersed (as is the case in this study). Fourthly, the likelihood of contamination or distortion of the respondent's answer is low with application of this method. Fifthly, the method suits closed type questions that are not too complex.

3.3.3 Design of the research questionnaire

The dimensions and elements of Environmental Management and Profitability were tapped to develop the test items of the research instrument. The research strategy employed in the study is the survey method since it allows the collection of a large amount of data from a large population and the data was collected using a questionnaire to allow data standardisation and comparison (Saunders *et al*. 2003).
The research questionnaire contained six demographic questions about the respondent and sixty-four test items that tapped the dimensions and elements of nine constructs. The research questionnaire is attached as Appendix A.

Byrne (1994, p.5) states that "although the choice of psychometrically sound instruments has an important effect on the credibility of all study findings, such selection becomes even more critical when the observed measure is presumed to represent an underlying latent construct." A five-point Likert scale was used as the rating scale in the research questionnaire. The Likert scale is "an itemized rating scale which offers a category of responses out of which the respondent picks the one that is most relevant for answering the question under consideration". The scale was anchored with polar points 1 = Strongly Disagree and 5 = Strongly Agree. The following coding applied:

1 = Strongly Disagree
2 = Disagree

3 = Neutral

4 = Agree

5 = Strongly Agree

In this coding, Neutral implies that the respondent does not know the answer to the question. Elmore and Beggs (1975; cited by Sekaran 1992, p.168) state that "research indicates that a 5-point scale is just as good as any and that an increase from 5 to 7 or 9 points on a rating scale does not improve the reliability of the ratings." Since an interval scale allows coding, it has the advantage of allowing the researcher to perform arithmetic calculations on the data collected from the respondents.

The survey form was designed as a web page using the computer program Microsoft FrontPage version 2000. It consisted of seven web pages with content described below.

- An introduction page which gave a summary of the purpose of the research as well as the research objectives and provided a table of contents to allow the respondent to move between pages.
- A page which provided an abstract of the research and a page which provided the corresponding references used in the abstract.
- A personal page which included the professional and academic background of the researcher.
- A page which included detailed instructions on completion of the questionnaire, as well as a brief description of each of the constructs.
- A page which contained the research questionnaire and asked the demographic information of the participant.
- A page which contained a letter of declaration.

All the pages of the website are listed as Appendix B.

The letter of declaration ensured the participant of confidentiality of his or her responses and provided the respondent with contact details of the research team. The questionnaire was designed in such a way that the response data file was sent automatically to the researcher's personal email address.

The layout of the questionnaire was designed to promote a simple, but interesting visual appearance and make reading questions and completing responses easy for the respondent. This was achieved with consistent use of shading, colour, font sizes, spacing and formatting of the questions. The coding of the rating scale was omitted from the visual web page but included in the formatting of the radio buttons used for response categories.

Also, the links between pages were designed to facilitate easy movement between pages. For example, a direct hyperlink was placed in item 15 of the research questionnaire (page six) to link it to the definition of the term "product life-cycle analysis" on page five. Where references were obtained from the world wide web, the corresponding web address was placed in the reference note to allow a direct link to the address.

In an attempt to personalize the contact with the respondent somewhat, a photograph of the researcher was inserted in page four, the professional background of the researcher. Finally, the respondent was thanked for their time and cooperation in completing the questionnaire.

3.3.4 Limitations of online administration

A possible problem anticipated with the use of online administration of questionnaires was a very low response rate (10% or less). Also, non-response bias was expected as the respondent had to take extra steps to locate and complete the questionnaire (Coomber 1997; cited by Saunders *et al*. 2003, p.312). Non-response bias makes it difficult to obtain a representative sample and this in turn will affect the generalizability of the research.

3.4 Validity of the Research Questionnaire

Saunders *et al*. (2003, p.291) state that "the validity and reliability of the data you collect and the response rate you achieve depend, to a large extent, on the design of your questions, the structure of your questionnaire, and the rigour of your pilot testing". This study aims to measure the interrelations between variables and as such "each measure must validly measure what it purports to measure" (Nunnally and Bernstein, 1994, p.84).

Sekaran (1994, p.209) states that "validity establishes how well a technique, instrument, or process measures a particular concept, and reliability indicates how stably and consistently the instrument taps the variable".

Nunnally and Bernstein (1994) states that validity is divided into three categories: (1) *construct* validity, (2) *predictive* validity and (3) *content* validity.

Construct validity measures how well the results obtained from the test measures fit the theory. It is divided into *convergent* validity and *discriminant* validity. *Convergent* validity occurs when two different instruments are used to measure the same concept and high correlation is obtained between the groups of indicators (Hatcher 1994; Nunnally and Bernstein 1994). *Discriminant* validity occurs when two different variables are measured and the groups of indicators are uncorrelated (Hatcher 1994; Sekaran 1992).

Predictive validity is the ability of a measure to predict a future criterion (Sekaran 1992) and *content* validity is "a measure of how well the dimensions and elements of a concept have been delineated" (Sekaran 1992, p.171). Face validity is the minimum index of content validity.

The following actions were taken to promote the validity of the research instrument.

3.4.1 Face validity of research questionnaire

Firstly, the wording of the questions was checked against a checklist of sixteen questions given by Saunders *et al*. (2003, p.299). "The checklist assists the researcher to avoid the most obvious problems associated with wording that threaten the validity of the responses". For example, question 4 of the checklist asks the following: "Are the words used in your question familiar, and will all respondents understand them in the same way?" Consequently, test item 10 of the research questionnaire was modified to include an example of an environmental management system (ISO 14001) to ensure that all respondents interpret the question correctly.

Secondly, the research instrument was pilot tested by subjecting it to a panel of experts that validated the proposed test items and made comments and recommendations on the representativeness and suitability of the questions. This exercise served as content validation of the research instrument.

Selection of expert panel

Saunders *et al*. (2003) recommend that the number of people chosen for the expert panel should be sufficient to include any major variations in the population that may affect the responses. The population of this study was divided into the following sectors: Mining, Healthcare (hospitals), Textiles, Chemicals, FMCG (fast moving consumer goods), Petroleum, Pulp and paper, Utilities, Food processing and Hospitality (hotels).

For purposes of the representativeness of the expert panel four alternative sectors were developed: Business, Academic, Environmental Specialists and Manufacturing. The members of the panel were then selected as follows: a total of sixteen experts were selected from the four sectors; four representatives were chosen from the Business and Academic sectors, three were chosen from the Environmental Specialists sector and five were chosen from the Manufacturing sector. The sectors are defined below.

- Environmental specialists included senior representatives of Environmental consultants, the South African Business Council for Sustainable Development and the Council for Science and Industry Research.
- Manufacturing included top or senior management representatives of companies that have implemented (or were in the process of implementing) environmental management in their firms. Sectors included were the pulp and paper industry, the chemical manufacturing industry, the furniture manufacturing industry and the textile manufacturing industry.
- Business included senior representatives from the utilities sector, mining sector, petroleum sector and food processing sector.
- Academics included individuals who have specialised in environmental management, pollution research and environmental economics from four different South African academic institutions.

Initially, the panel members were contacted via telephone and asked whether they would participate in the research exercise. After their permission had been received, the research instrument and a cover letter explaining the objectives of the research were sent to the participants via email – communication via email was a specific request of all the panel members. Included in the correspondence were an abstract of the research, a brief description of each construct, detailed instructions on completion of the questionnaire, the theoretical research model and specific requirements of the participant regarding the questionnaire completion. The original cover letter, including signatures of both the researcher and the supervisor, was then sent to the respondent via postal mail. After one week a reminder email was sent to all the participants and within two weeks a total of eight responses were received from the original sixteen requests. Seven of these responses were received via email and one response was obtained by telephonic interview. The letter is attached as Appendix C.

The response rate of fifty percent was accepted by the researcher. Finally, a thank-you note was sent to each respondent via email.

Summary of results

Included in the original research instrument were four reverse-coded items. All the respondents stated that these negatively-worded questions were difficult to interpret and that they created confusion in answering the question. However, Saunders *et al*. (2003) strongly recommend the use of reverse-coded questions since it forces the respondent to think about answering the question. As such, the negatively-worded questions were included in the final research instrument.

One respondent recommended that the scale point "Neutral" should imply that the respondent is indifferent or impartial to the question (instead of the implication "Do not know"). The researcher did not apply this recommendation because it would have produced missing data in the data analysis.

Several panel members stated that they did not understand the following terms used in the test items and requested the terms to be clearly defined for the participant: end-of-pipe technology, barrier-to-market entry and product life-cycle analysis. The terms were clearly defined in the final administration of the questionnaire.

The original research questionnaire was six A4 pages in length. One respondent noted that the questionnaire might be too long. Six other respondents did not comment on the length of the questionnaire and the final respondent stated that if the number of items in the questionnaire were reduced, the questionnaire would be incomplete. After posting of the research questionnaire on the Internet website it was found that the questionnaire was too lengthy and that the respondents might lose interest towards the end, thereby affecting reliability of the findings.[2] As a result, the researcher studied the questionnaire again to determine if items could be removed and consequently reduced the questionnaire to five A4 pages (from eighty-five test items to seventy test items). Saunders *et al*. (2003, p.304) notes that a questionnaire length of between four and eight A4 pages is acceptable for self-administered questionnaires.

Several respondents suggested changes in item wording to clarify the question – most of these suggestions were incorporated in the final design of the questionnaire. For example, originally item 45 of the research questionnaire read as follows: Environmental management only costs the firm money. The respondents found this statement difficult to interpret and it was consequently changed to: Environmental management has been a net expense for the firm.

Three additional items were suggested by the respondents and consequently added to the questionnaire. One such example is the addition of item 39: Key personnel are appointed for environmental issues.

Two respondents noted that they felt uneasy about answering item 20 (originally worded: Our firm engages in environmental lawsuits) and that they did not fully understand the question. The question was reworded as follows: Our firm has been involved in environmental legal proceedings.

No comments were made regarding the proposed research model.

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[2] As discussed with Professor Paskaramoorthy, University of the Witwatersrand (11th December 2003)

Limitations of face validity

The following statement by Nunnally and Bernstein (1994, p.84) is noted by the researcher:

> There is no way to prove the validity of an instrument purely by appeal to authority, deduction from a psychological theory, or mathematical proof.

From this statement the researcher notes that the use of an expert panel is not sufficient on its own to establish the validity of a research instrument. Secondly, most of the participants that were chosen for the study were all highly involved in environmental management and as such they possessed significant knowledge of the subject. This may have affected the validity of the results in that no non-specialists partook in the expert panel.

3.4.2 Construct validity

Scientific generalization is an important aspect of research. To ensure scientific generalization, it is important to demonstrate construct validity. Nunnally and Bernstein (1994, p.86) states that "there are three major aspects of construct validation: (1) specifying the domain of observables related to the construct, (2) determining the extent to which the observables tend to measure the same thing and… (3) performing subsequent individual differences studies".

This research study will answer to the first two aspects since there was not sufficient time to perform aspect three. The first and second aspects deal with how well measures of observed variables inter-correlate empirically. As such, factor analysis will be performed on the sample data to obtain information about the structure of the observables relating to a construct. Test items measure the same concept (or construct) if their inter-correlation are high – implying high construct validity. Construct validity will be established in Chapter 5.

3.5 Population and Sample Selection

Sekaran (1992) notes that both the sampling design and sample size are important to establish the representativeness of a sample for generalizability. The application of these criteria is discussed below.

3.5.1 Population frame

The population of the study consisted of companies operating throughout South Africa in ten different sectors, namely mining, healthcare (hospitals), textile manufacturing, chemical manufacturing, FMCG (fast moving consumer goods) manufacturing, petroleum, pulp and paper, utilities, food processing and hospitality (hotels).

A problem encountered in determining the population frame was that initially, the researcher could not obtain a comprehensive directory which listed all the companies in the chosen sectors in South Africa. The following directories were investigated and found lacking.

1. The SABS Register publication 2001 – 2002.
2. The Johannesburg Stock Exchange Handbook publication January 2003 – June 2003.
3. The internet directory Brabys.com.

Finally, the directory Ezeedex was consulted and found to be the most comprehensive listing of South African-based firms. The directory provided contact names, telephone numbers and direct email addresses of the listed firms. The researcher chose this directory for it being the most comprehensive listing of companies with email addresses in South Africa and proceeded with the study.

3.5.2 Sample design

Probability sampling was applied to support the type of investigation used in this research, namely establishing a causal relationship between variables. Sekaran (1992, p.229) states that "probability sampling designs are used when the representativeness of the sample is of importance for purposes of wider generalizability." Specifically, disproportionate stratified systematic sampling was applied according to flow diagrams presented by Sekaran (1992, p.239) and Saunders *et al*. (2003, p.163). The population "was divided into mutually exclusive groups that are relevant, appropriate and meaningful in the context of the study."

Selection of sample subgroups

Due to a lack of data on natural resource consumption (excluding energy) and waste generation per sector, the common criterion for selection of these subgroups was the energy consumption of each sector. According to the Digest of South African Energy Statistics (2002) the major energy consuming sectors are the following:

- Industry (41.3% of total energy demand).
- Transport (27.5% of total energy demand).
- Residential (16.4% of total energy demand).
- Commerce (3.8% of total energy demand).
- Agriculture (2.9% of total energy demand).

The industry sector includes iron and steel, chemical and petrochemical, non-ferrous metals, non-metallic minerals, transport equipment, machinery, food and tobacco, paper pulp and print, wood and wood products, construction and textile and leather. The commerce sector included Hospitality and Healthcare.

Also, the Standard Industrial Classification (SIC 2) divides the South African industry into ten sectors (Department of Trade and Industry, 2003):

1. Food products, beverages and tobacco.
2. Textiles, clothings and leather.
3. Wood, cork products, straw, paper, publishing and printing.
4. Coke, petroleum, nuclear fuel, chemicals, rubber and plastics.
5. Non-metallic minerals.
6. Basic metals, machinery and equipment.
7. Electrical machinery and apparatus.
8. Radio, television and communication.
9. Transport equipment.
10. Furniture and recycling.

This classification was used as a guideline for the selection of the industrial sectors of this research study.

The subgroups of the research study included the following ten sectors: mining, healthcare, textile manufacturing, chemical manufacturing, FMCG (fast moving consumer goods) manufacturing, petroleum, pulp and paper, utilities, food processing and hospitality.

The healthcare sector included government, provincial and private hospitals. The petroleum sector included manufacturers of gases, oil, lubricants, petrol and fuels. The FMCG sector included manufacturers of furniture, cement additives, baby care products, vehicles, bearings, cans and drums, beauty products and cosmetics, television and radio, containers, packaging, disinfectants and insecticides. The pulp and paper sector included forest timbers, paper bag manufacturers and paper manufacturers. The utilities sector included all power stations. The food processing sector included farming, wine and beverage manufacturers and food manufacturers. The hospitality sector included hotels. The textile manufacturing sector included manufacturers of textile and leather goods. The Ezeedex directory allows for filters to be applied in the search of companies and two were used: an email filter to allow listing of companies with direct email addresses and a filter for manufacturer to allow listing of manufacturers (excluding distributors and sales). The filter for manufacturer was not applied to the hospitality and healthcare sectors.

Probability sampling

The subgroup representation of each sample was selected disproportionately because (a) the subgroups did not have an equal number of elements and (b) it cannot be shown that the population frame for each stratum is all-inclusive (Sekaran 1992). In each stratum the participating companies were then drawn using random systematic sampling. Table 5 illustrates the population frame, number of companies in each sector and the corresponding percentage representation obtained from the Ezeedex directory.

Table 5 Population frame of South African-based firms in ten sectors

Sector	**Total number of companies**	**Percentage representation**
Mining	354	8%
Healthcare	363	8%
Textiles	303	7%
Chemicals	1277	28.5%
FMCG	1000	22%

Petroleum	207	5%
Pulp and paper / forestry	8	0.2%
Utilities	15	0.3%
Food processing	593	13%
Hospitality	347	8%
TOTAL	**4467**	**100%**

3.5.3 Sample size

The unit of analysis selected for this study was representatives from top and middle management of firms. Since this research aims to determine whether a relationship exists between environmental management strategies and profitability, it was decided that participants in these designations were best informed to answer the test items.

Sekaran (1992) notes that multivariate research should employ a sample size several times (preferably ten times or more) as large as the number of variables. In this study there are a total of sixty four variables that measure the nine constructs of environmental management and profitability. It follows that the sample size should consist of at least six hundred and forty participants.

According to Saunders *et al*. (2003) the minimum sample size of a population of approximately five thousand cases is 357 participants at a 95 per cent confidence level. The following equation is used to calculate the actual sample size – it includes an estimated response rate.

Actual sample size $n^a = \frac{n \times 100}{re\%}$ ……………………………………………..***Equation 1***

Where n is the minimum sample size, *re%* is the response rate as a percentage and n^a is the actual sample size.

Saunders *et al*. (2003) state that a ten percent response rate can be used for online administration of questionnaires. A higher response rate of thirty percent was employed since the researcher had access to personal email addresses of the respondents and it was believed that direct communication with the respondent would increase the response rate.

Using equation 1, the actual sample size is calculated as follows:

$n^a = \frac{357x100}{30} = 1190$ cases……………………………………………***Equation 1***

The sample size, however, was limited by the agreement between the researcher and the managing director of Ezeedex. The verbal agreement allowed the researcher access to six hundred participating companies with two respondents per company. The Ezeedex directory, however, only provided one thousand contact details in the correct designations of top and middle management and as such the sample size was limited to one thousand participants.

The actual sample size of one thousand participants still met the criteria of multivariate research that the sample size should be larger than ten times the number of variables.

Table 6 illustrates the final sample size and selection using disproportionate random sampling.

Table 6 Sample selection of South African-based firms in ten sectors

Sector	Number of respondents	Percentage representation
Mining	136	14%
Healthcare	123	12%
Textiles	114	11%
Chemicals	170	17%
FMCG	161	16%
Petroleum	100	10%
Pulp and paper / forestry	20	2%
Utilities	7	1%
Food processing	109	11%
Hospitality	60	6%
TOTAL	**1000**	**100%**

3.6 Data Collection

The time horizon of the study was cross-directional and the data was gathered once over a period of four weeks. An email containing a brief description of the research and objectives was sent to the participants; it also contained a direct link to the Internet web address. It was requested that the participants return the completed questionnaire to the researcher within one week. The design of the research questionnaire allowed the return of the questionnaire directly to the researcher via email. The first email sent to the participants is given in Appendix D.

A few of the respondents provided both positive and negative feedback to the research. Mr. Ron Weissenberg, the Chief Executive Officer of the Micronized Group, responded as follows[3]:

> Date: 28 January 2004
>
> Dear Ms Nel
>
> Having been involved in the Junior / small scale sector of SA mining for many years, I am pleased that this research is taking place. Utilising first world statute in a combined third-world economy has been most damaging to our sector. I hope your research may provide some answers.
>
> Take care and best wishes
>
> Ron Weissenberg
>
> CEO – Micronized Group

Another participant, Mr. Henk Schuiling of a company called Air Systems / AheadTech responded to the research as follows[4]:

[3] Email communication from Ron Weissenberg, dated Wednesday, January 28, 2004 11:12 AM
[4] Email communication from Henk Schuiling, dated Thursday, February 19, 2004 12:50 AM

Date: 19 February 2004

Dear Hannelie

Your questionnaire seems very "black and white". I am definitely one to support conservation and acting responsible towards the plant and its people. However I think the "rock around the rain forest" club has also got the cat by the (those things that easily hurt). ISO 14001 is cool but often goes beyond practicality and human survival, especially where small business is concerned.

At the end of the day one should try and instill an awareness (the type that would encourage someone to not litter when no one is watching – that' s like an acid test) and balance the human need (After all we are also part of the environment), nature, technology, personal work and home environment, etc.

Anyway, good luck with your Masters

Kindest Regards

Hank Schuiling

Mech Eng (NDip), TLP, QBE

The first email from a chief executive officer in the mining sector provided affirms that the current research is very necessary in South Africa. The researcher provides conclusions and recommendations based on the data analysis in Chapters 7 and 8.

The second email makes the important point that environmental management practices may be hurting small business in South Africa.

Saunders *et al*. (2003, p.157) state that non-response is due to four problems:

- Refusal to respond;
- Ineligibility to respond;
- Inability to locate respondent;
- Respondent located but unable to make contact.

The respondents and non-respondents of this study are discussed below. Non-respondents contribute to bias in the representativeness of the sample.

After one week 45 completed questionnaires and 23 non-responses were received. After the second week 36 completed questionnaires and 5 non-responses were received. At the beginning of the third week a reminder was sent to the participants requesting them to return the completed questionnaire if they had not already done so (see Appendix E). This was followed by another reminder within seven days. The first reminder produced an additional 5 responses and 2 non-responses. The second reminder produced 39 responses and 25 non-responses. At the end of the fourth week total of 125 completed questionnaires were received and a total of 55 non-responses. This constitutes a response rate of 12.5%.

The reasons given by non-respondents are shown in the Figure 9. The Pareto diagram indicates that 78% of non-responses were due to four reasons:

(a) Thirteen questionnaires were sent to companies in sectors which did not form part of the study (including research and development, marketing, distribution and engineering contractors). The reason for this is that the Ezeedex database incorrectly labelled these firms as manufacturers.

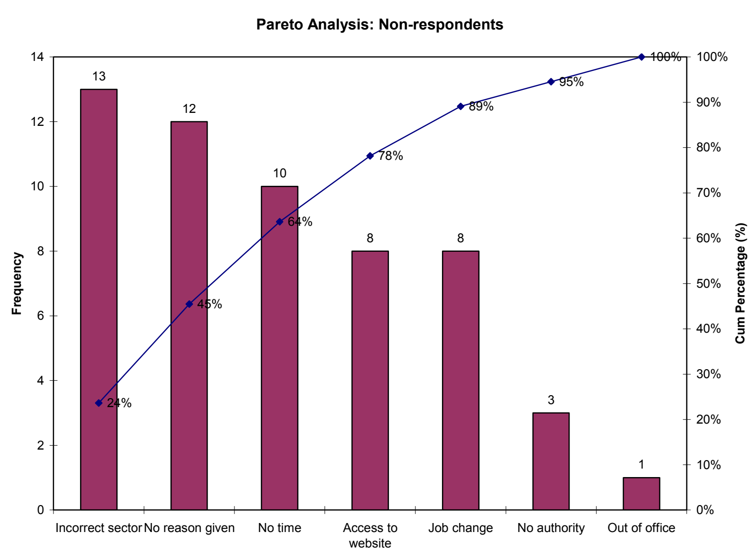
(b) Twelve respondents gave no reason for their non-response, only indicating that they were not willing to participate in the research study.

(c) Ten respondents stated that they did not have time to complete the questionnaire.

(d) Eight respondents were willing to complete the questionnaire but they were denied access to the website. The research questionnaires were then sent to these participants in Microsoft Word format. These questionnaires were either not returned or returned with incomplete information (and could therefore not be used).

Other reasons for non-responses included participants who had changed positions in the firm or had left the firm. Participants also indicated that they did not have the authority to complete the questionnaire or the firm's policy denied disclosure of the information required. Finally, one respondent was out of office and did not return in time to complete the questionnaire.

Figure 9 Non-respondent analysis



4. DATA ANALYSIS THEORY

4.1 Preparation of Data for Analysis

The SAS (Statistical Analysis System) computer package was used for data analysis. The raw data received from the respondents were entered into a data matrix with two dimensions: the number of cases (respondents) entered in the column and the number of variables entered into rows. The variables were coded V1 to V70, corresponding to the test items 1 to 70.

The web response method was designed to allow only completed questionnaires to be returned to the researcher. Each question contained a "Do not know" response represented by "Neutral" and was coded with the number 3. The research instrument contained seven negatively-worded questions that were reversed to reflect the intended response.

Accuracy of data entry was ensured by spot-checking every tenth record (Sekaran 1992, p.281) and no mistakes were found. The data was ready for analysis.

Sekaran (1992, p.282) states that "In data analysis we have three objectives: getting a feel for the data, testing the goodness of the data, and testing the hypotheses developed for the research." Each of these objectives is discussed below.

4.2 Descriptive Statistics

Descriptive statistics was used to "describe (and compare) the variables numerically" (Saunders *et al*. 2003, p.251). The mean, range, standard deviation and variance in the data was analysed to determine the response range over the scale and show whether the questions were properly worded, whether the respondents understood the questions and whether bias was present (Sekaran 1992).

Frequency distributions and bar charts were used to analyse the demographic characteristics of the respondents.

4.3 Inferential Statistics

4.3.1 Statistical significance

Statistical significance was tested using the chi square test: a test to determine whether the relationship between variables could occur by chance alone if the sample were representative of the population (Saunders *et al*. 2003). If the probability (*p*-value) is 0.05 or smaller there is a 95% confidence level that the relationship between two variables did not occur by chance alone and the relationship is thus statistically significant.

4.3.2 Hypotheses testing

Ten hypotheses were generated in this research. Two-tailed *t*-tests were used to test the null hypothesis H_O because H_A is non-directional in all hypotheses. Glasnapp and Poggio (1985, p.317) state that "A two-tailed test of H_O establishes a region of rejection and critical value in two tails of the probability distribution." The *t* tests used in the study are equivalent to large-sample z tests and the *t*-value is therefore statistically significant at a 95% confidence level ($p < 0.05$) whenever the absolute value of *t* exceeds 1.96 (Hatcher 1994).

4.4 Reliability

Hatcher (1994) states that it is very important to assess scale reliability early in the data analysis since there is no point in performing additional analysis if the scales used in the study were not reliable.

"The reliability of a measure indicates the stability and consistency with which the instrument is measuring the concept and helps to assess the “goodness” of the data" (Sekaran 1992, p.173). A reliability coefficient indicates the variance in an observed variable accounted for by true scores given by participants in a study – it therefore excludes the measurement error associated with the score (Hatcher 1994). An instrument is said to be reliable when it provides consistent scores with repeated administration and with administration by alternate forms (Hatcher 1994).

Two tests can be used to determine scale reliability: (1) the test-retest reliability and (2) internal consistency reliability (Hatcher 1994). The first test is usually impractical due to time constraints. Cronbach’s alpha reliability coefficient is used for multipoint scaled items (as used in this research) and measures the consistency with which the respondents answer all the items in a measure – it is also known as the internal consistency reliability of a scale (Hatcher 1994). "Internal consistency is the extent to which the individual items that constitute a test correlate with one another or with the test total" (Hatcher 1994, p.132). The formula for Cronbach’s alpha is given below (Hatcher 1994):

$$\alpha = \left(\frac{N}{N-1}\right) \times \left(\frac{S^2 - \sum S^2{}_i}{S^2}\right) \quad \text{.......................................} \textbf{\textit{Equation 2}}$$

where

α = Cronbach’s coefficient alpha

N = number of items constituting the instrument

S = sum of the scale score

S^2 = variance of the summated scale score

Cronbach (1951, p.331) states that "α estimates, and is a lower bound to, the proportion of test variance attributable to common factors among the items".

Cronbach's coefficient alpha is widely used as a measure of internal consistency reliability and was therefore applied in this research.

The coefficient is analysed as follows (Sekaran 1992 and Hatcher 1994):

Where Cronbach's $\alpha > 0.8$ the internal consistency reliability is good (the items in the scale are highly correlated with one another and there are a sufficient number of items).

Where Cronbach's $\alpha < 0.6$ the internal consistency reliability is poor (the items in the scales show a low correlation with one another and / or there are not a sufficient number of items).

Where Cronbach's $0.6 < \alpha > 0.8$ the internal consistency reliability is acceptable.

4.5 Structural Equation Modelling

4.5.1 Confirmatory factor analysis

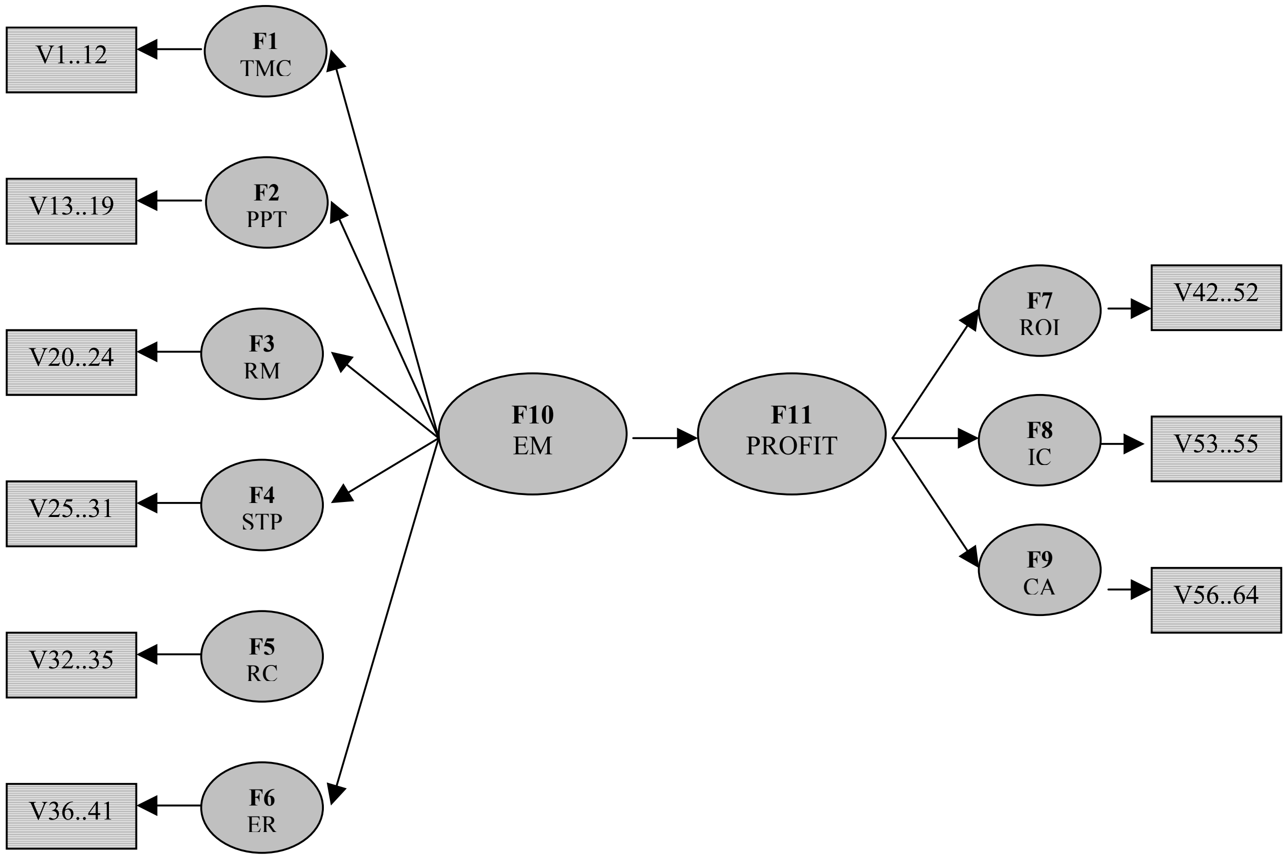
This study follows a two-step approach to test the latent-variable model Environmental Management and Profitability, using the SAS System's PROC CALIS procedure for analysis.

The first step involves using confirmatory factor analysis to develop an acceptable measurement model. The measurement model does not specify causal relationships between the latent variables, but only allows all latent variables to covary with each other. The measurement model provides evidence that the indicator variables are measuring the underlying latent constructs and that the model provides an acceptable fit to the data (Hatcher 1994). Confirmatory factor analysis is used because the researcher is making an assumption of an underlying causal structure of the model: it is suggested that the covariation in the observed variables is due to the presence of one or more latent factors that exert causal influence on these observed variables. Confirmatory factor analysis (as opposed to exploratory factor analysis) is used because the researcher is hypothesizing the existence of certain factors (obtained from delineation of the concepts environmental management and profitability) and then confirming the existence of these factors with factor analysis.

The study follows the convention by Bentler (1989; cited by Hatcher 1994) of identifying latent factors with the letter F and manifest variables with the letter V. An oval represents a latent factor: it is latent because it cannot be measured directly. A square represents an observed variable and V1 represents the first test item of the research questionnaire (as an example). Observed variables can be measured directly by the response of a participant to the test item. One-directional causal relationships are indicated by a one-directional arrow and covariances are indicated by curved, two-directional arrows.

The Environmental Management and Profitability model of this study consists of nine constructs: Environmental Management is described by six factors, namely Top Management Commitment, Risk Management, Stakeholder Partnerships, Employee Relations, Product and Process Technology and Resources Conservation. Profitability is described by three factors, namely Return on Investment, Intellectual Capital and Competitive Advantage. The proposed Environmental Management and Profitability model to be tested is given in Figure 10. The figure indicates that the latent factor Top Management Commitment (F1) is measured by the indicator variables V1 to V12 and the latent factor Product & Process Technology (F2) is measured by the indicator variables V13 to V19 (for example).

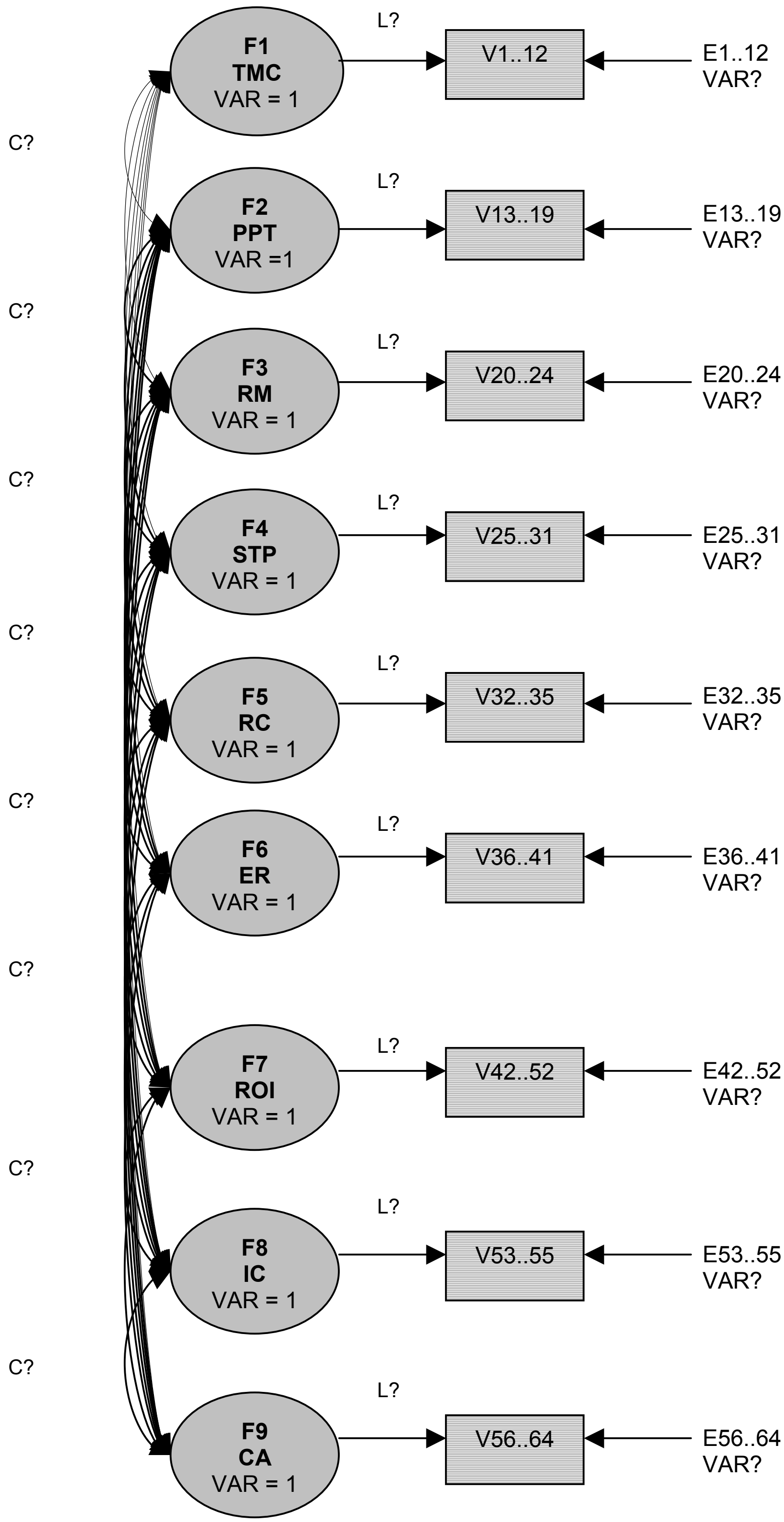
Figure 10 Proposed model of Environmental Management and Profitability



4.5.2 Program figure for SAS PROC CALIS

Preparation of a program figure is required for programming in PROC CALIS. A program figure identifies all the factors and indicator variables of the model and includes residual terms and all parameters to be estimated. Figure 11 represents the program figure for confirmatory factor analysis: also known as the initial measurement model of the study.

Figure 11 Initial Measurement Model



The figure shows that a residual, or error term has been identified for each endogenous variable (V1 to V64). Therefore indicator variable V1 has been assigned an error term E1 and its' variance must be estimated: indicated by VAR? "The residual term for a variable represents all the factors that influence variability in that variable, but are not included as antecedent variables in the model" (Hatcher 1994, p. 156). A hypothetical construct (all F variables) has no real-life scale or metric by which it is measured and this creates an indeterminancy problem. To circumvent this problem, the variance of all latent factors has been fixed at a standard of 1 (Hatcher 1994).

Furthermore, the symbol C? on each curved, double-headed arrow represents the covariance to be estimated between each F factor and the symbol L? represents the factor loading to be estimated. In path analysis, factor loadings are also known as path coefficients (or standardized linear weights) and they represent the "size of the effect that an underlying factor has in causing variability in the observed variable" (Hatcher 1994, p. 65).

Finally, it is necessary to verify that the model is over-identified for programming: the SAS Log Output of PROC CALIS does not allow data analysis otherwise. An over-identified model implies that the number of known parameters (such as the indicator variables variances and covariances) is greater than the number of unknown parameters to be estimated. In the PROC CALIS output, the degrees of freedom for the model chi-square is a measure of the degrees of the over-identified model. The PROC CALIS program for the initial measurement model is attached as Appendix F.

4.5.3 Equations for confirmatory factor analysis

In this study confirmatory factor analysis is applicable because the observed variables (or effect indicators) are regarded as outcomes of the underlying latent variables (Nunnally and Bernstein 1994). For example, five observed variables (V20 to V24) are effect indicators of the latent variable Risk Management. As such, the effect indicators are linear combinations of the factor and thus dependent on the factor. The factors (independent variables) are considered error-free and the observed variables (dependent variables) contain error (Nunnally and Bernstein 1994).

Figure 11 shows that the latent factors influence the observed variables and the observed variables are therefore the weighted sum of its' underlying factors. The figure also illustrates that factors F1 to F9 are common factors: factors that influence more than one observed variable (Hatcher 1994). For example, F1 is a common factor of V1 to V12.

Factor 3 Risk Management has been enlarged in Figure 12 to illustrate its observed variables. The L coefficient denotes the factor loading between a variable and a factor: a factor loading represents the correlation of the variable with a factor.

Figure 12: Risk management factor loadings

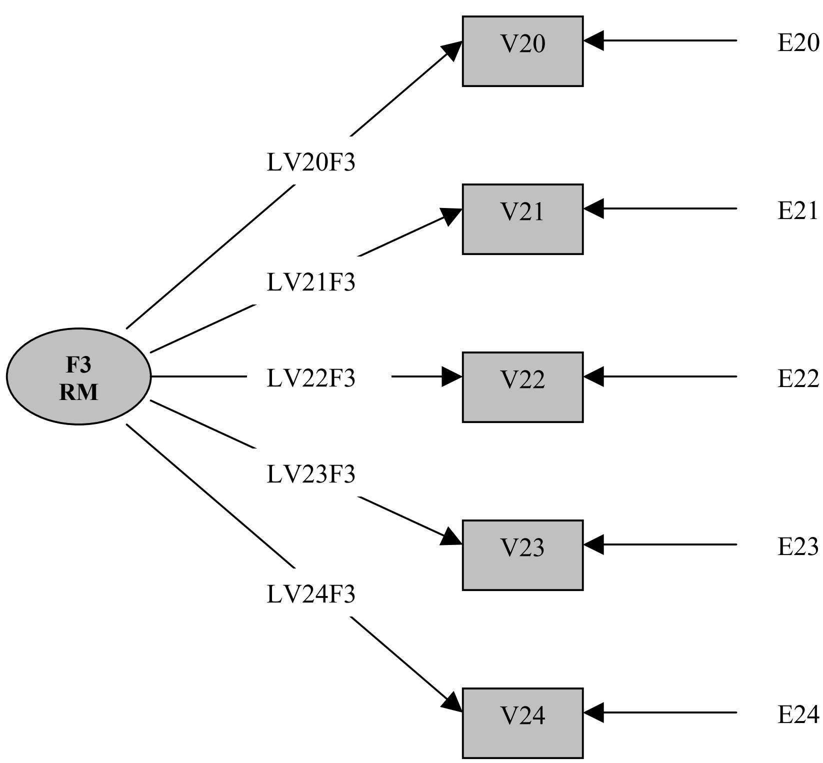


Figure 12 shows that the factor loading of V20 on F3 is LV20F3 and that a unique error term E20 influences the variable V20. The following equations illustrate the observed variables in Figure 12 written as the weighted sum of the underlying factors in the model (Hatcher 1994; Kim and Mueller 1978):

$$V20 = LV20F3\ F3 + E20$$
$$V21 = LV21F3\ F3 + E21$$
$$V22 = LV22F3\ F3 + E22$$
$$V23 = LV23F3\ F3 + E23$$
$$V24 = LV24F3\ F3 + E24$$

$$\text{cov}(F3, E20) = \text{cov}(F3, E21) = \text{cov}(F3, E22) = \text{cov}(F3, E23) = \text{cov}(F3, E24) = 0$$
$$\text{cov}(E20, E21) = \text{cov}(E21, E22) = \text{cov}(E22, E23) = \text{cov}(E23, E24) = 0$$

The last two equations indicate that no covariance exists between factors and residual terms and no covariance exists between error terms.

Similarly, all the observed variables in the study (V1 to V64) can be expressed as the sum of its' weighted underlying factors (see Appendix F).

4.5.4 Path analysis with latent variables

The second step is path analysis with latent variables – firstly, the measurement model is modified in order to specify causal relationships between some of the latent variables – this is known as the theoretical model of the study. Secondly, the theoretical model is modified to provide an acceptable and parsimonious fit to the data. Parsimony and fit indices are calculated for the modified causal models until a good model fit is achieved.

The initial theoretical model is given in Figure 13. The theoretical model consists of two components:

- A measurement model that specifies the relationships between the latent constructs.
- A structural model that specifies causal relationships between the latent constructs.

4.5.5 Assumptions

The following assumptions should be met to conduct confirmatory factor analysis and path analysis with latent variables (Hatcher 1994, p. 259):

1. All endogenous variables (manifest variables) should be assessed on an interval- or ratio-level of measurement.

2. Indicator variables should be continuous and assume a minimum number of four values.

3. The statistical tests used by SAS PROC CALIS (such as the model chi-square test and significance tests for path coefficients) assume multivariate normality.

4. The relationships between variables should be linear and additive.

5. Variables should be free of multicollinearity – a condition that exists when one or more variables exhibit very strong correlations (> 0.80) with one another.

6. All independent variables should be measured without error; in other words, each manifest variable should be a perfectly reliable indicator of the underlying construct that it is intended to measure. Cronbach's alpha is used to indicate reliability of constructs before data analysis commences.

7. All nontrivial causes of a model's endogenous variables should be included in the model as independent variables (included in the program figure as error or E variables) and the error variables should be noncorrelated.

8. The causal model must be overidentified.

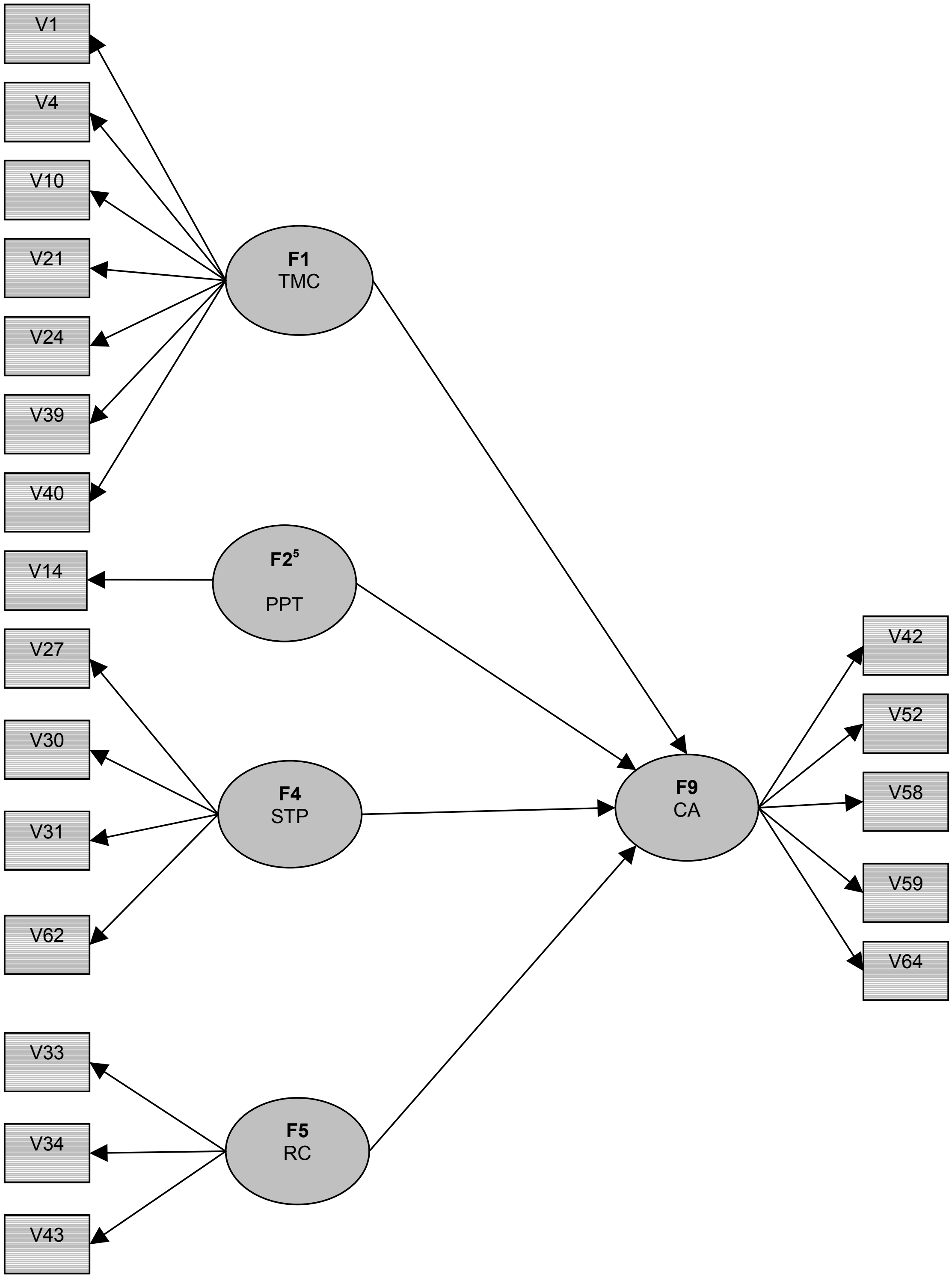
9. The minimum number of observations should be the larger of 150 observations or 5 observations per parameter to be estimated. This is required for generalizability. The number of observations in this study is 125 and Cronbach's alpha coefficient is sufficiently large for the raw data to indicate reliability of the test items.

10. At least three indicator variables should measure a latent factor. For factor F2, see footnote 5.

11. A maximum of 20 to 30 indicator variables should be used in the study. A larger data set may result in large chi-square values and an inability to fit the model to the data. This study used 64 indicator variables to measure the underlying factors. As a result, the initial measurement model displayed a very large chi-square and it took 14 iterations to obtain a good model fit.

Figure 13 Initial Theoretical Model [5]

[5] In Iteration 14, the analysis of the non standardized factor loadings indicates that V14 displays a zero standard error and a standardized factor loading of 1. Therefore, factor F2 is measured completely by V14.



4.5.6 Input data

The SAS System PROC CALIS procedure uses a covariance matrix as data input (Hatcher 1994). The procedure transforms a correlation matrix of Pearson correlation coefficients[6] into a covariance matrix (see PROC CALIS program in Appendix F).

The Pearson correlation coefficients and standard deviations for the data are given in Appendix G. The Pearson product-moment correlation or Pearson correlation for short (*r*) is used to denote the direction and degree of the linear relationship between two variables. Pearson *r* ranges from -1.00 to + 1.00: the higher the value of the coefficient, the greater the relationship between two variables (Glasnapp and Poggio 1985). Pearson *r* is computed with the following formula:

$$r_{xy} = \frac{n\Sigma XY - (\Sigma X)(\Sigma Y)}{\sqrt{[n\Sigma X^2 - (\Sigma X)^2][n\Sigma Y^2 - (\Sigma Y)^2}} \quad \text{.......................................} \textbf{\textit{Equation 3}}$$

where:
X = raw scores on the variable X
Y = raw scores on the variable Y
n = sample size

4.5.7 Good fit measurement model

The purpose of confirmatory factor analysis to obtain a measurement model that provides a good fit to the data. The SAS System PROC CALIS procedures provide goodness of fit indices and other information against which the model is tested for fit. Hatcher (1994, p. 339) gives nine conditions which must be met for a measurement model to provide an good fit to the data. The conditions are listed below.

1. The *p* value for the model chi-square test should be non significant.

[6] The Pearson correlation coefficient is recommended by Hatcher (1994, p.563) when both the predictor and criterion variables are assessed on an interval level of measurement.

2. The ratio of chi-square to degrees of freedom should be less than 2.

3. The goodness of fit index (GFI) should be higher than 0.80. Bentler's comparative fit index (CFI) and Bentler and Bonett's non-normed fit index (NNFI) should both exceed 0.90.

4. The absolute value of the *t* statistic for each factor loadings should exceed 1.96 at $p < 0.05$ (a 95% confidence level).

5. The standardized factor loadings should be significant (in this study, factor loadings were considered significant if the value ≥ 0.60).

6. The distribution of normalized residuals should be symmetrical and centered on zero and relatively few or no normalized residuals should exceed an absolute value of 2.

7. Composite reliabilities for the latent factors should exceed 0.70.

8. Variance extracted estimates for the latent factors should exceed 0.50.

9. Discriminant validity and convergent validity should be demonstrated.

4.5.8 Eigenvalue and interpretability criteria

Two final criteria were used to confirm that the final revised measurement model was correct: the eigenvalue criterion and the interpretability criterion.

The eigenvalue criterion (or Kaiser-Guttman rule) is used to confirm that the number of components extracted by the measurement model is correct. An eigenvalue represents the amount of variance that is accounted for by a given component

(Hatcher 1994, p.22). According to the Kaiser-Guttman rule, a factor is retained when it has an eigenvalue ≥ 1 or the factors are retained that contribute to a value of 1 for the cumulative proportion (Nunnally and Bernstein 1994, p.482). Table 16 in Appendix I shows that five factors are retained.

A scree plot was also used to graphically represent the size of the eigenvalue associated with each factor (see Figure 27 in Appendix I).

Finally, the constructs and indicator variables of the final revised measurement model are checked against the following interpretability criteria (Hatcher 1994, p.30):

- Are there at least three items with significant loadings on each retained factor?
- Do the variables that load on a given factor share the same conceptual meaning?
- Do the variables that load on different constructs seem to be measuring different constructs?

The interpretability criterion is discussed in Appendix I.

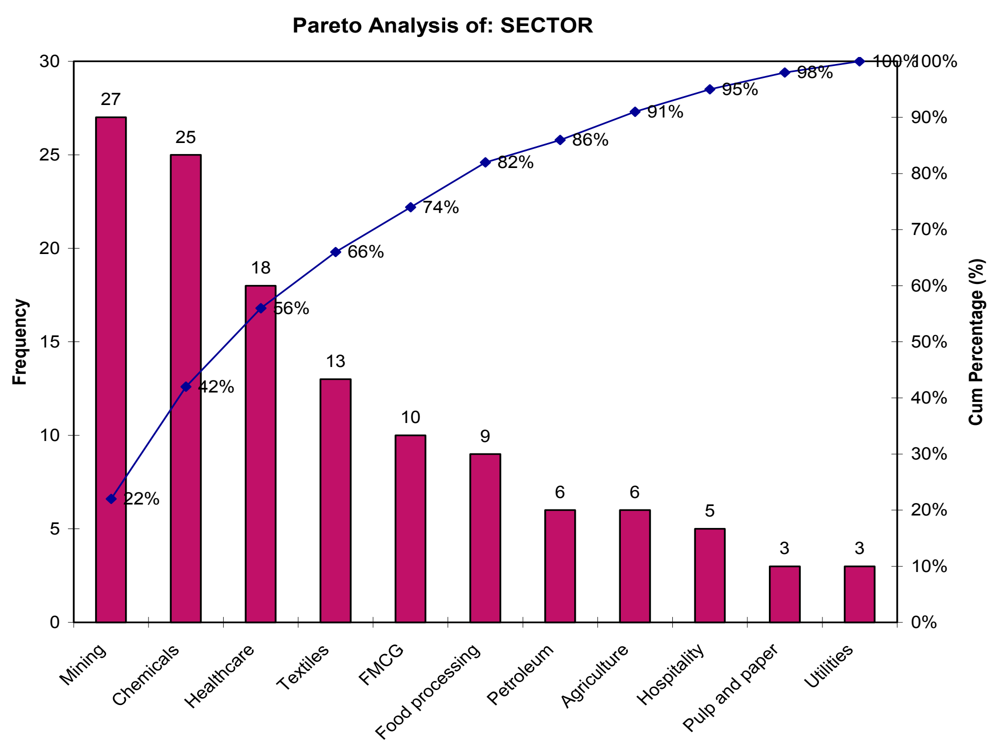
5. RESULTS

5.1 Demographic Information

For all data analysis, the sample size N = 125.

Figure 14 shows the number of respondents per sector. 82% of respondents were from the Mining, Chemicals, Healthcare, Textiles, FMCG (fast moving consumer goods) and Food processing industries.

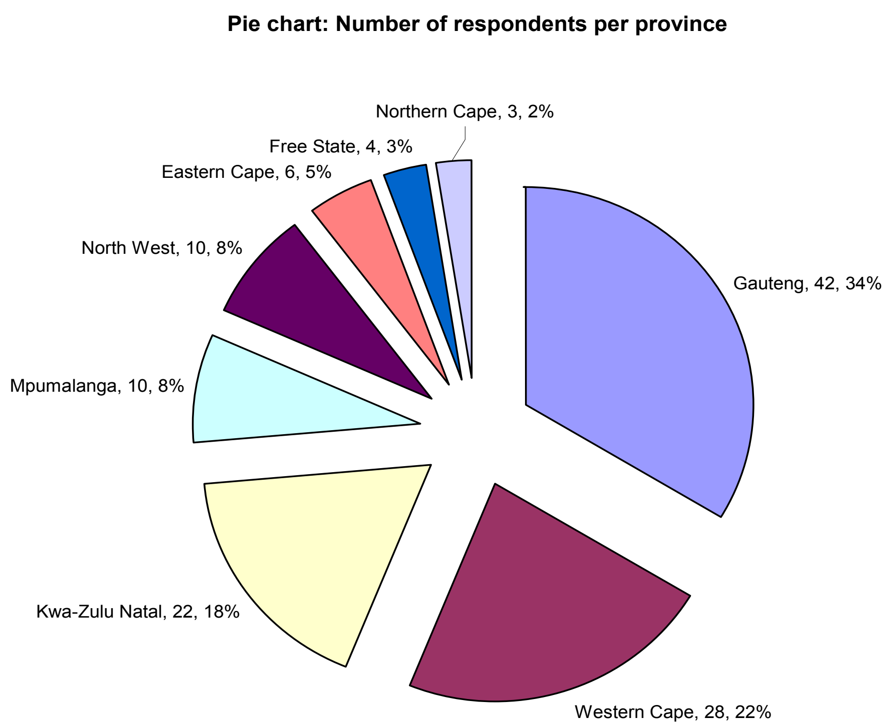
Figure 14 Sector analysis



The respondent data corresponds with the sample selection given in Table 6: 14% of the sample represented the mining sector and 22% of the respondents were from mining. 17% of the sample represented the chemical sector and 20% of the respondents were from this sector. 12% of the sample represented the healthcare sector and 14% of the respondents were from healthcare. 11% of the sample represented the textile sector and 10% of the respondents were from this sector.

Figure 15 indicates the number of respondents and percentage of respondents from each province.

Figure 15 Number of respondents per province



It is clear that the highest number of respondents were from Gauteng (34%), followed by the Western Cape (22%) and Kwa-Zulu Natal (18%).

The designation of respondents is indicated in Figure 16. The bar chart indicates that the majority of respondents were from director, top management and middle management designations. Two respondents were from the designation "Other" and one respondent from the designation of "Supervisor". These results confirm that the correct unit of analysis for the study participated in the research.

Figure 16 Respondent designation

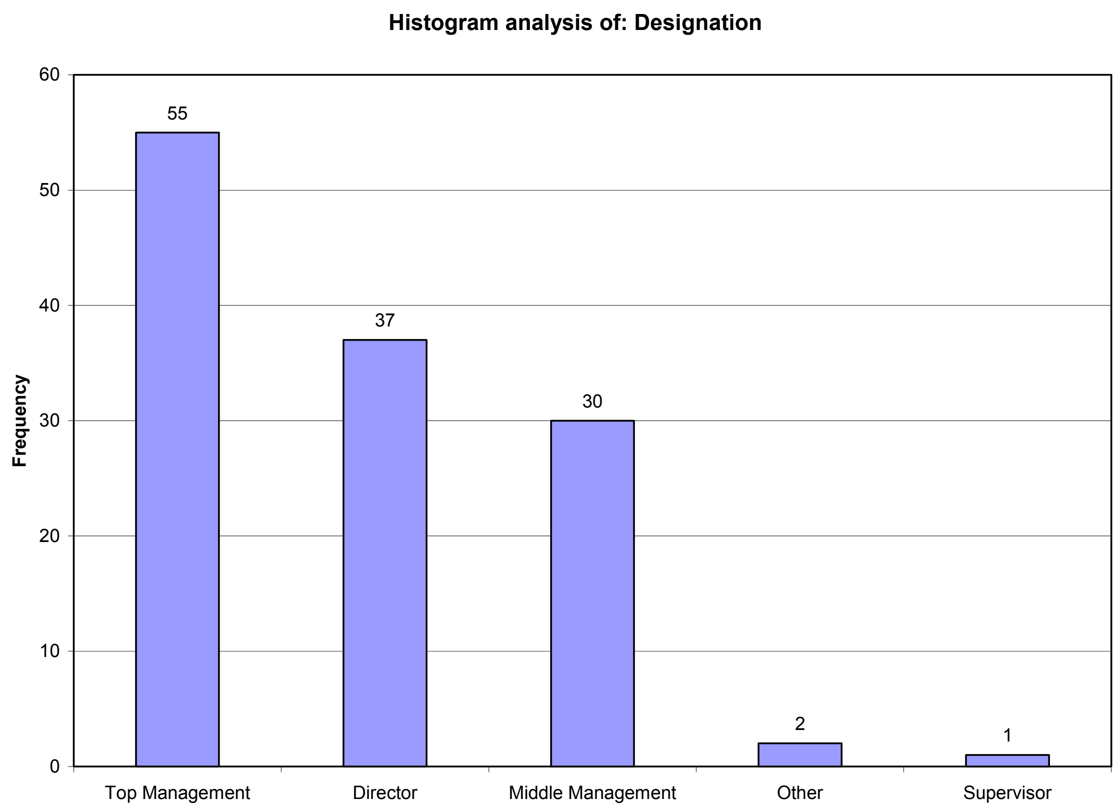


Figure 17 shows that 81% of the respondents indicated that the annual turnover of their division is less than R500 000.

Figure 17 Annual turnover per division

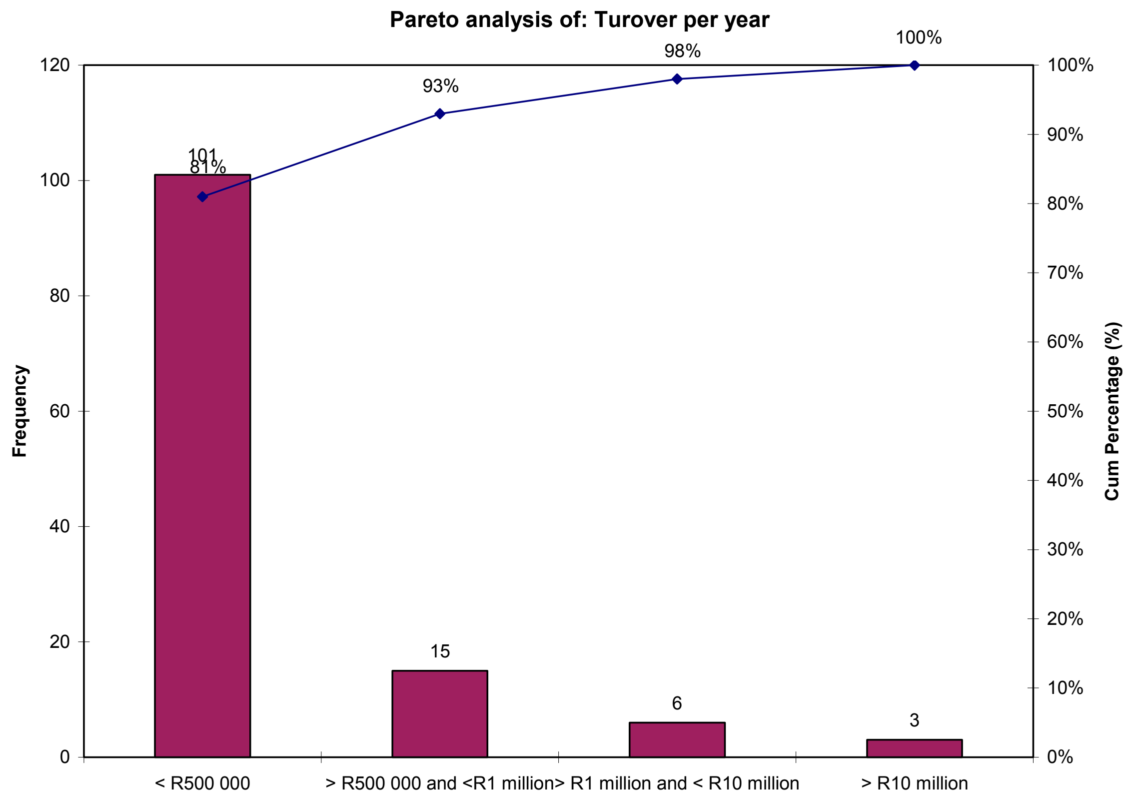
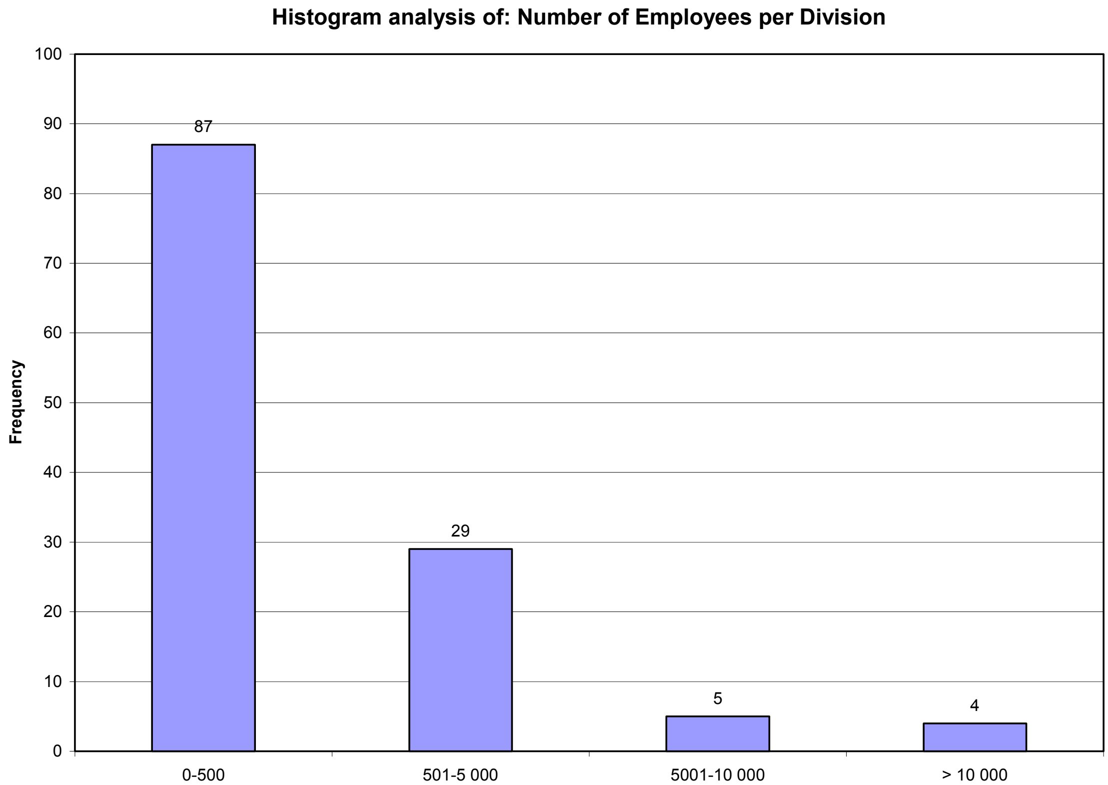


Figure 18 shows that the majority of respondents indicated that the number of employees per division was fewer than 500.

Figure 18 Number of employees per division



Finally, 78% of respondents indicated that the number of years worked in the company exceeded six years. Only three respondents had a service history of less than one year.

5.2 Univariate analysis

Path analysis with latent variables assumes multivariate normal distribution of the variable indicators (Hatcher 1994). Normality of the indicator variables was determined using the SAS System UNIVARIATE procedure. Shapiro-Wilk statistics for the indicator variables were significant at p-values < 0.0001 (given in Appendix M): the statistics show that the indicator variables did not display multivariate normality. "Structural equation modelling, however is still unbiased and efficient in the absence of multivariate normality if the residuals are multivariate normally distributed with means of 0 and if the residuals are not correlated with each other" (Structural Equation Modeling 2002, p. 43). The standardized residuals of the initial measurement model displayed properties of normal distribution (Output 5) – it was centered on zero and symmetrical about the center. This implies that the findings of this study are still valid despite non normality of the indicator variables.

The mean, standard deviation and variance for each indicator variable were examined to ensure that the respondents answered the test items within the scale range and show whether the questions were properly worded. The data is given in Appendix M. The data also indicates whether or not the researcher made any mistakes with data entry (Hatcher 1994). All the data were within the scale range indicating that that no response bias was present (Sekaran 1992).

5.3 Internal Consistency Reliability

The first step in data analysis is to assess the reliability of the scale used. Cronbach's coefficient alpha was calculated to determine the reliability of the scale and to assess the internal consistency of the test items measuring the factors: the consistency with which the respondents answered all the items in a measure.

The coefficient is analysed as follows (Sekaran 1992 and Hatcher 1994):

Where Cronbach's $\alpha > 0.8$ the internal consistency reliability is good (the items in the scale are highly correlated with one another and there are a sufficient number of items).

Where Cronbach's $\alpha < 0.6$ the internal consistency reliability is poor (the items in the scales show a low correlation with one another and / or there are not a sufficient number of items).

Where Cronbach's $\alpha > 0.6$ and $\alpha < 0.8$ the internal consistency reliability is acceptable.

Table 7 gives Cronbach's coefficient alpha for all factors in the original questionnaire.

The table indicates that all the factors demonstrate a coefficient higher than 0.7 for the standardized variables. Cronbach's alpha is thus acceptably high in all cases to infer that there were a sufficient number of test items included in the scale and that the items that constitute the scale are highly correlated with one another. This conclusion allows further analysis of the data.

Table 7 Coefficient alpha reliability estimates for the factors

Variables		**Cronbach Coefficient Alpha Standardized Variables**
F1	Top Management Commit	0.9151
F2	Prod & Process Technology	0.7794
F3	Risk Management	0.7341
F4	Stakeholder Partnerships	0.8364
F5	Resource Conservation	0.8499
F6	Employee Relations	0.8278
F7	Return on Investment	0.8106
F8	Intellectual Capital	0.7428
F9	Competitive Advantage	0.8495

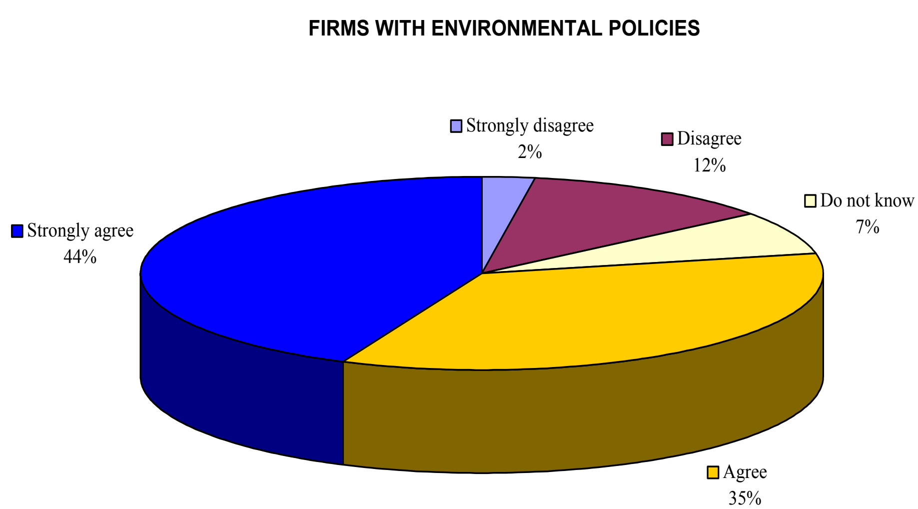
N=125

5.4 Frequency Tables and Diagrams

5.4.1 Environmental management systems

The chart in Figure 19 indicates that 79% of the respondents agreed that their firms had an existing environmental policy. However, only 57% of the same respondents stated that their firms had implemented (or were in the process of implementing) an environmental management system such as ISO 14001. This data supports findings from a study by KPMG in 1998 that slightly more than fifty percent of listed companies in South Africa had an environmental management system (Visser 1998). The data indicates that little progress has been made in five years.

Figure 19 Firms with environmental policies



5.4.2 ROI and the cost of environmental management

In South Africa, only 32% of the respondents measure the return-on-investment of environmental initiatives. 30% of the respondents do not know whether the ROI is measured and 37% state that they do not measure the ROI (response to question V44).

Environmental management costs the firm a significant amount of money solicited the following response: 45% of the respondents agreed that environmental management is costly, 35% of the respondents do not know and 19% of the respondents disagreed with this statement (response to question V45).

Since the unit of analysis of the study is top and middle management designations, it is interesting to note that one third of the respondents did not know the answer to these two questions. The responses are given in Table 8.

Table 8 Response to V44 and V45

Response	V44 (% frequency)	V45 (% frequency)
Disagree	**37%**	**19%**
Do not know	**30%**	**35%**
Agree	**32%**	**45%**

This data supports the statement by Visser (1998) that South African firms perceive environmental management to be costly. It also corresponds with the findings by Naidoo (2002) that only 25% of listed companies disclosed their environmental <u>financial</u> performance in 2002.

5.4.3 Environmental regulation

Table 9 indicates that 77% of the respondents believe that environmental regulation is a major concern for their firm (response to V24). And 68% of the respondents agreed that compliance with environmental regulation has reduced their firm's financial risk (response to V57).

19% of the firms stated that environmental regulation is not a major concern for their firm and that compliance with environmental regulation does not reduce their firm's financial risk. One third of the respondents from Healthcare, Agriculture, Food Processing and Utilities stated that they were not concerned with environmental regulation. Also, 50% of the Petroleum sector, 40% of the Hospitality sector and 22% of the Textiles sector stated that environmental regulation is not a major concern for their firms.

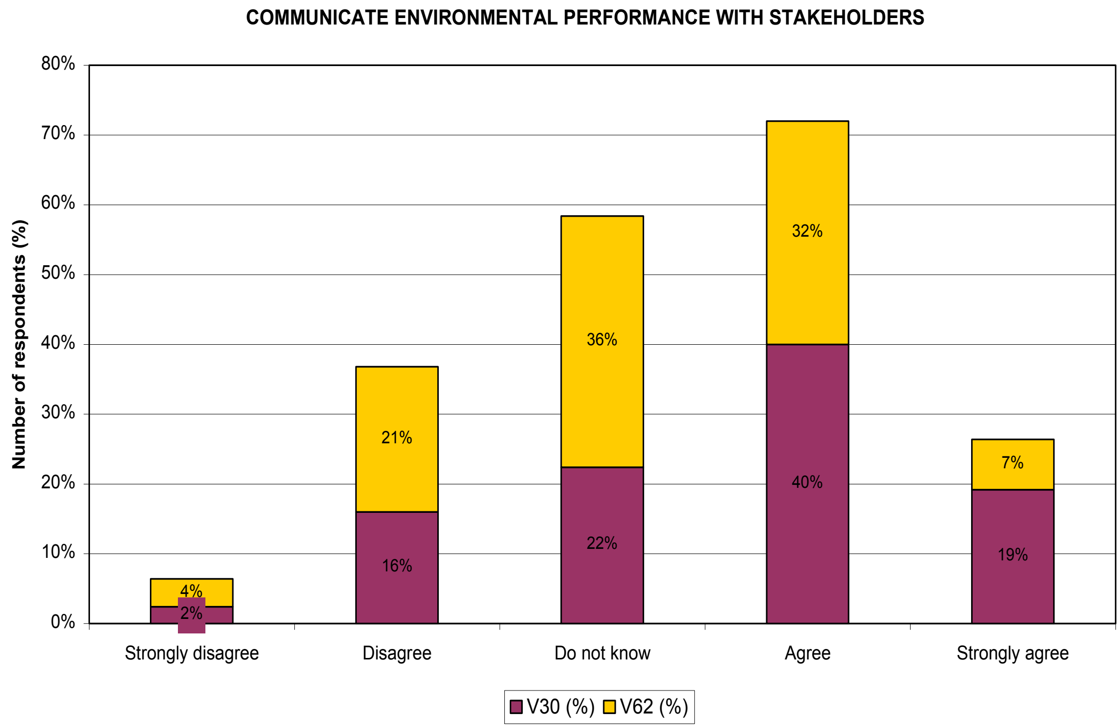
Table 9 Response to V24 and V57

Response	V24 (% frequency)	V57 (% frequency)
Disagree	**19%**	**19%**
Do not know	**4%**	**12%**
Agree	**77%**	**68%**

5.4.4 Communication of environmental performance data

Finally, 59% of the respondents stated that they communicate their firm's environmental performance data with stakeholders (response to V30). 39% of the respondents agreed that communication of environmental performance data promoted strong relationships with stakeholders (response to V62). This is indicated in Figure 20.

Figure 20 Responses to V30 and V62



5.5 Confirmatory Factor Analysis

A two step approach is followed to test the latent-variable model of this study (Hatcher, 1994). The first step involves using confirmatory factor analysis to develop an acceptable measurement model. An "acceptable measurement model" implying that the indicator variables are measuring the underlying constructs and that the measurement model demonstrates an acceptable fit to the data (Hatcher, 1994). The measurement model does not test causal relationships between the constructs and as such, all factors are allowed to covary.

The second step is known as path analysis with latent variables and its purpose is to modify the measurement model to predict causal relationships between constructs and to test hypotheses developed in the study.

5.5.1 Developing a measurement model with confirmatory factor analysis

The initial measurement model is again shown in Figure 21. The model includes all parameters to be estimated in the confirmatory factor analysis executed in SAS PROC CALIS.

The process for developing an acceptable measurement model starts with reviewing the overall goodness of fit indices, including the chi-square test, Bentler's Comparative Fit Index (CFI) and Bentler & Bonett's Non-normed Fit Index (NNFI). Then more detailed assessment of fit indices is reviewed and these include significance tests for factor loadings, R^2 values, normalized residuals and modification indices (Hatcher, 1994).

The measurement model is revised until the following conditions are met:

(a) The model demonstrates an acceptable fit to the data as indicated by CFI and NNFI (values > 0.9 are acceptable).

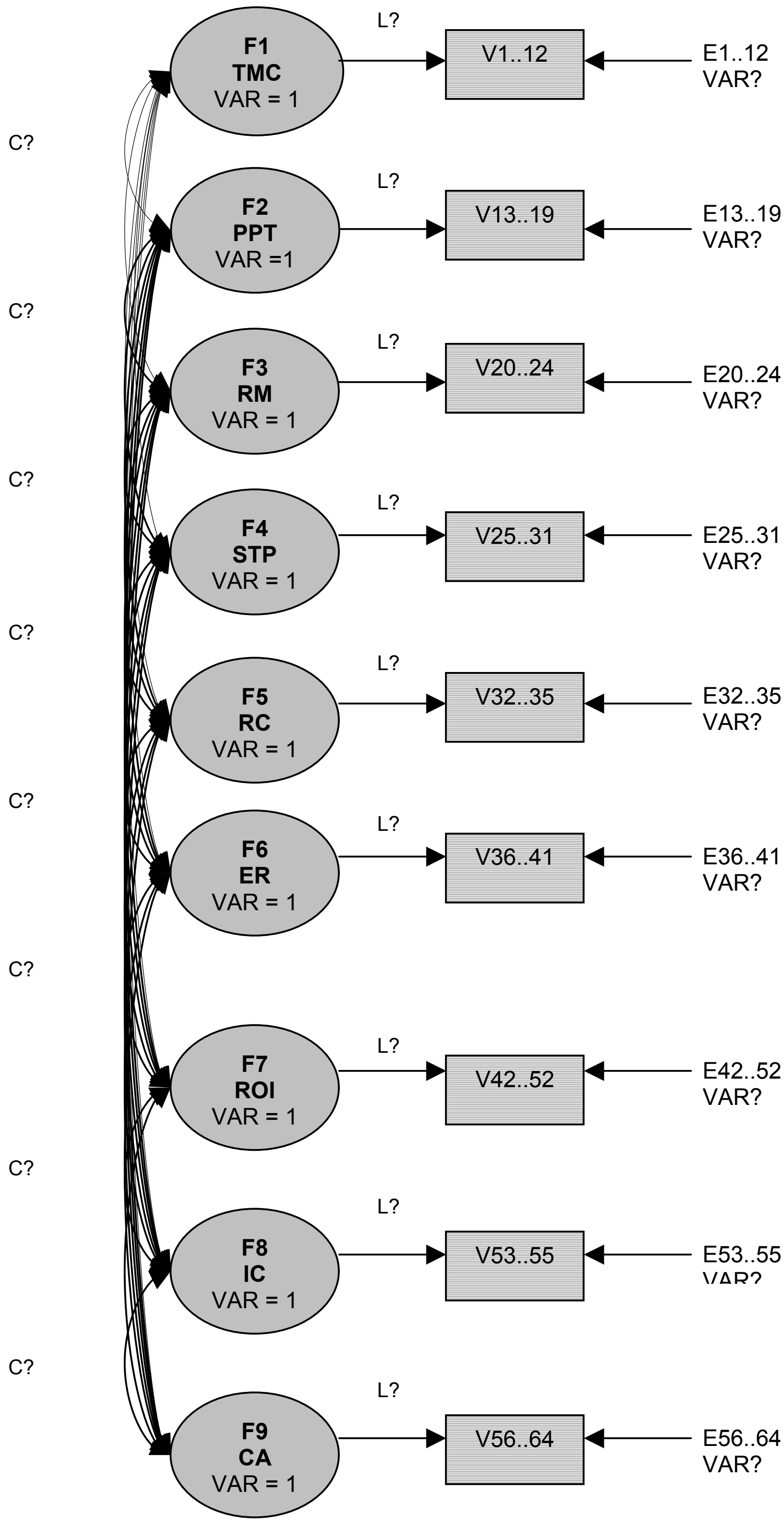
(b) The displays no non-significant factor loadings (absolute values > 0.6 are acceptable).

(c) The displays no large normalized residuals (absolute values < 2.0 are acceptable)

5.5.2 Assessing the fit between model and data

Output 1 provides the goodness of fit statistics for the first confirmatory factor analysis iteration.

Figure 21 Initial measurement model



Output 1 Goodness of fit statistics: initial measurement model

```
                                   The CALIS Procedure
                  Covariance Structure Analysis: Maximum Likelihood Estimation

Line 1            Fit Function                                           29.8728
Line 2            Goodness of Fit Index (GFI)                             0.5294
Line 3            GFI Adjusted for Degrees of Freedom (AGFI)              0.4892
Line 4            Root Mean Square Residual (RMR)                         0.0862
Line 5            Parsimonious GFI (Mulaik, 1989)                         0.5032
Line 6            Chi-Square                                           3644.4799
Line 7            Chi-Square DF                                             1916
Line 8            Pr > Chi-Square                                         <.0001
Line 9            Independence Model Chi-Square                           7366.9
Line 10           Independence Model Chi-Square DF                          2016
Line 11           RMSEA Estimate                                          0.0860
Line 12           RMSEA 90% Lower Confidence Limit                        0.0817
Line 13           RMSEA 90% Upper Confidence Limit                        0.0902
Line 14           ECVI Estimate                                          35.6272
Line 15           ECVI 90% Lower Confidence Limit                              .
Line 16           ECVI 90% Upper Confidence Limit                              .
Line 17           Probability of Close Fit                                0.0000
Line 18           Bentler's Comparative Fit Index                         0.6770
Line 19           Normal Theory Reweighted LS Chi-Square               3469.7661
Line 20           Akaike's Information Criterion                       -187.5201
Line 21           Bozdogan's (1987) CAIC                              -7491.6654
Line 22           Schwarz's Bayesian Criterion                        -5575.6654
Line 23           McDonald's (1989) Centrality                            0.0009
Line 24           Bentler & Bonett's (1980) Non-normed Index              0.6601
Line 25           Bentler & Bonett's (1980) NFI                           0.5053
Line 26           James, Mulaik, & Brett (1982) Parsimonious NFI          0.4802
Line 27           Z-Test of Wilson & Hilferty (1931)                     22.2054
Line 28           Bollen (1986) Normed Index Rho1                         0.4795
Line 29           Bollen (1988) Non-normed Index Delta2                   0.6829
Line 30           Hoelter's (1983) Critical N                                 69
```

Step 1: Reviewing the chi-square test

Hatcher (1994, p.289) states that "In real-world applications, therefore, it has become common practice to seek a model with a *relatively small* chi-square value, rather than necessarily seek a model with a *nonsignificant* chi-square…...researchers typically attempt to develop a model with a chi-square value that is small in relation to the *df*." An informal criterion that is used to determine that the model may be acceptable is a ratio of chi-square to degrees of freedom < 2.

The data for the chi-square test for the model is given in Output 1 (lines 6 and 7):

Chi-square = 3644.48 and *df* = 1916 with Pr > Chi-square <0.0001.

$$\text{Ratio} = \frac{3644.48}{1916} = 1.9 \ldots\ldots \textbf{\textit{Equation 4}}$$

The ratio is < 2 with a p value < 0.0001 which is highly significant. This index indicates that the model does not fit the data.

Step 2: Reviewing GFI, NNFI and CFI

The goodness of fit index (GFI) should be larger than 0.8 to indicate an acceptable model fit and values over 0.9 on both the NNFI and CFI are acceptable. Output 1 provides the following data:

GFI = 0.5294 (line 2)
CFI = 0.6770 (line 18)
NNFI = 0.6601 (line 24)

The GFI < 0.8 and CFI and NNFI are both lower than 0.9 indicating a poor model fit.

Step 3: Reviewing significance tests for factor loadings

In this study, a non significant factor loading value less than 0.6 was used to show that the indicator variable is not a good measure of the underlying factor and that (a) it should be reassigned to another factor or (b) dropped from the analysis.

Output 2 presents the nonstandardized factor loadings for the initial measurement model.

Output 2 Non-standardized factor loadings: initial measurement model

```
                    The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation
```

Manifest Variable Equations with Estimates

```
V1       =   0.5664*F1       +  1.0000 E1
Std Err      0.0714 LV1F1
t Value      7.9298
V2       =   0.8916*F1       +  1.0000 E2
Std Err      0.0817 LV2F1
t Value     10.9077
V3       =   0.8245*F1       +  1.0000 E3
Std Err      0.0751 LV3F1
t Value     10.9797
V4       =   0.8066*F1       +  1.0000 E4
Std Err      0.0750 LV4F1
t Value     10.7481
V5       =   0.4974*F1       +  1.0000 E5
Std Err      0.1204 LV5F1
t Value      4.1326
V6       =   0.5588*F1       +  1.0000 E6
Std Err      0.0836 LV6F1
t Value      6.6833
V7       =   0.7274*F1       +  1.0000 E7
Std Err      0.0816 LV7F1
t Value      8.9100
V8       =   0.9576*F1       +  1.0000 E8
Std Err      0.0893 LV8F1
t Value     10.7235
V9       =   0.8277*F1       +  1.0000 E9
Std Err      0.0837 LV9F1
t Value      9.8826
V10      =   0.9010*F1       +  1.0000 E10
Std Err      0.1060 LV10F1
t Value      8.4972
V11      =   0.6415*F1       +  1.0000 E11
Std Err      0.0873 LV11F1
t Value      7.3443
V12      =   0.8665*F1       +  1.0000 E12
Std Err      0.0982 LV12F1
t Value      8.8261
V13      =   0.5730*F2       +  1.0000 E13
Std Err      0.1117 LV13F2
t Value      5.1300
V14      =   0.7126*F2       +  1.0000 E14
Std Err      0.0904 LV14F2
t Value      7.8819
V15      =   0.6363*F2       +  1.0000 E15
Std Err      0.0873 LV15F2
t Value      7.2922

V16      =   0.4237*F2       +  1.0000 E16
Std Err      0.0970 LV16F2
t Value      4.3696
V17      =   0.4803*F2       +  1.0000 E17
Std Err      0.0826 LV17F2
t Value      5.8165
V18      =   0.6096*F2       +  1.0000 E18
Std Err      0.0822 LV18F2
t Value      7.4144
V19      =   0.8030*F2       +  1.0000 E19
Std Err      0.0903 LV19F2
t Value      8.8902
V20      =   0.2892*F3       +  1.0000 E20
Std Err      0.1078 LV20F3
```

```
t Value     2.6820
V21     =   0.9283*F3      +  1.0000 E21
Std Err     0.0978 LV21F3
t Value     9.4955
V22     =   0.6377*F3      +  1.0000 E22
Std Err     0.0690 LV22F3
t Value     9.2473
V23     =   0.6135*F3      +  1.0000 E23
Std Err     0.0889 LV23F3
t Value     6.8988
V24     =   0.8019*F3      +  1.0000 E24
Std Err     0.0954 LV24F3
t Value     8.4076
V25     =   0.6685*F4      +  1.0000 E25
Std Err     0.0820 LV25F4
t Value     8.1490
V26     =   0.4649*F4      +  1.0000 E26
Std Err     0.0701 LV26F4
t Value     6.6351
V27     =   0.7732*F4      +  1.0000 E27
Std Err     0.0776 LV27F4
t Value     9.9670
V28     =   0.3671*F4      +  1.0000 E28
Std Err     0.0902 LV28F4
t Value     4.0695
V29     =   0.7092*F4      +  1.0000 E29
Std Err     0.0833 LV29F4
t Value     8.5140
V30     =   0.8697*F4      +  1.0000 E30
Std Err     0.0793 LV30F4
t Value    10.9662
V31     =   0.6808*F4      +  1.0000 E31
Std Err     0.0859 LV31F4
t Value     7.9276

V32     =   0.7922*F5      +  1.0000 E32
Std Err     0.0819 LV32F5
t Value     9.6712
V33     =   0.7809*F5      +  1.0000 E33
Std Err     0.0852 LV33F5
t Value     9.1683
V34     =   0.6941*F5      +  1.0000 E34
Std Err     0.0725 LV34F5
t Value     9.5785
V35     =   0.8252*F5      +  1.0000 E35
Std Err     0.0844 LV35F5
t Value     9.7718
V36     =   0.5317*F6      +  1.0000 E36
Std Err     0.0995 LV36F6
t Value     5.3414
V37     =   0.6665*F6      +  1.0000 E37
Std Err     0.0774 LV37F6
t Value     8.6088
V38     =   0.5557*F6      +  1.0000 E38
Std Err     0.0842 LV38F6
t Value     6.6001
V39     =   0.9468*F6      +  1.0000 E39
Std Err     0.0902 LV39F6
t Value    10.4941
V40     =   0.9089*F6      +  1.0000 E40
Std Err     0.0929 LV40F6
t Value     9.7884
V41     =   0.7768*F6      +  1.0000 E41
Std Err     0.0826 LV41F6
```

```
t Value     9.4025
V42     =   0.8278*F7      +  1.0000 E42
Std Err     0.0878 LV42F7
t Value     9.4265
V43     =   0.6742*F7      +  1.0000 E43
Std Err     0.0812 LV43F7
t Value     8.3066
V44     =   0.8443*F7      +  1.0000 E44
Std Err     0.0834 LV44F7
t Value    10.1171
V45     =  -0.0189*F7      +  1.0000 E45
Std Err     0.0897 LV45F7
t Value    -0.2105
V46     =   0.6881*F7      +  1.0000 E46
Std Err     0.0828 LV46F7
t Value     8.3097
V47     =   0.7111*F7      +  1.0000 E47
Std Err     0.0945 LV47F7
t Value     7.5231
V48     =   0.5595*F7      +  1.0000 E48
Std Err     0.0743 LV48F7
t Value     7.5321
V49     =   0.2507*F7      +  1.0000 E49
Std Err     0.0688 LV49F7
t Value     3.6456
V50     =   0.1434*F7      +  1.0000 E50
Std Err     0.1037 LV50F7
t Value     1.3836
V51     =   0.6117*F7      +  1.0000 E51
Std Err     0.0803 LV51F7
t Value     7.6186
V52     =   0.7249*F7      +  1.0000 E52
Std Err     0.0826 LV52F7
t Value     8.7743
V53     =   0.6160*F8      +  1.0000 E53
Std Err     0.0909 LV53F8
t Value     6.7758
V54     =   0.8022*F8      +  1.0000 E54
Std Err     0.0785 LV54F8
t Value    10.2218
V55     =   0.7516*F8      +  1.0000 E55
Std Err     0.0808 LV55F8
t Value     9.2963
V56     =   0.6721*F9      +  1.0000 E56
Std Err     0.0827 LV56F9
t Value     8.1239
V57     =   0.6478*F9      +  1.0000 E57
Std Err     0.0867 LV57F9
t Value     7.4706
V58     =   0.5638*F9      +  1.0000 E58
Std Err     0.0752 LV58F9
t Value     7.5012
V59     =   0.7205*F9      +  1.0000 E59
Std Err     0.0930 LV59F9
t Value     7.7501
V60     =   0.5234*F9      +  1.0000 E60
Std Err     0.0861 LV60F9
t Value     6.0816
V61     =   0.2519*F9      +  1.0000 E61
Std Err     0.0799 LV61F9
t Value     3.1523
V62     =   0.7988*F9      +  1.0000 E62
Std Err     0.0733 LV62F9
t Value    10.9044
```

```
V63      =   0.6688*F9       +  1.0000 E63
Std Err      0.0763 LV63F9
t Value      8.7679
V64      =   0.5863*F9       +  1.0000 E64
Std Err      0.0699 LV64F9
t Value      8.3937
```

The first step is to verify that there are no near-zero standard errors in the output: this may indicate an estimation problem of linear dependency. The standard error values appear in the output as "Std Err". All the standard errors are higher than zero in the current output.

The *t*-values represent large-sample *t* tests of the null hypothesis that the factor loading is equal to zero in the population; *t*-values greater than 1.960 are significant at $p < 0.05$ (a 95% confidence level). The output indicates that all *t*-values for non standardized factor loadings are significant (> 1.96) at $p < 0.05$.

The standardized factor loadings for the initial measurement model are given in Output 3.

Output 3 Standardized factor loadings: initial measurement model

```
                     The CALIS Procedure
  Covariance Structure Analysis: Maximum Likelihood Estimation

    Manifest Variable Equations with Standardized Estimates


         V1      =   0.6486*F1     +  0.7611 E1
                            LV1F1
         V2      =   0.8165*F1     +  0.5774 E2
                            LV2F1
         V3      =   0.8200*F1     +  0.5724 E3
                            LV3F1
         V4      =   0.8086*F1     +  0.5884 E4
                            LV4F1
         V5      =   0.3685*F1     +  0.9296 E5
                            LV5F1
         V6      =   0.5647*F1     +  0.8253 E6
                            LV6F1
         V7      =   0.7088*F1     +  0.7054 E7
                            LV7F1
         V8      =   0.8074*F1     +  0.5901 E8
                            LV8F1
         V9      =   0.7637*F1     +  0.6456 E9
```

```
                  LV9F1
V10     =   0.6840*F1     +  0.7294 E10
                  LV10F1
V11     =   0.6102*F1     +  0.7922 E11
                  LV11F1
V12     =   0.7038*F1     +  0.7104 E12
                  LV12F1
V13     =   0.4608*F2     +  0.8875 E13
                  LV13F2
V14     =   0.6606*F2     +  0.7507 E14
                  LV14F2
V15     =   0.6212*F2     +  0.7837 E15
                  LV15F2
V16     =   0.3986*F2     +  0.9171 E16
                  LV16F2
V17     =   0.5144*F2     +  0.8575 E17
                  LV17F2
V18     =   0.6295*F2     +  0.7770 E18
                  LV18F2
V19     =   0.7239*F2     +  0.6899 E19
                  LV19F2
V20     =   0.2525*F3     +  0.9676 E20
                  LV20F3
V21     =   0.7614*F3     +  0.6482 E21
                  LV21F3
V22     =   0.7470*F3     +  0.6648 E22
                  LV22F3
V23     =   0.5960*F3     +  0.8030 E23
                  LV23F3
V24     =   0.6962*F3     +  0.7178 E24
                  LV24F3
V25     =   0.6666*F4     +  0.7454 E25
                  LV25F4
V26     =   0.5651*F4     +  0.8251 E26
                  LV26F4
V27     =   0.7727*F4     +  0.6348 E27
                  LV27F4
V28     =   0.3660*F4     +  0.9306 E28
                  LV28F4
V29     =   0.6892*F4     +  0.7246 E29
                  LV29F4
V30     =   0.8242*F4     +  0.5663 E30
                  LV30F4
V31     =   0.6525*F4     +  0.7578 E31
                  LV31F4
V32     =   0.7662*F5     +  0.6426 E32
                  LV32F5
V33     =   0.7377*F5     +  0.6751 E33
                  LV33F5
V34     =   0.7611*F5     +  0.6487 E34
                  LV34F5
V35     =   0.7718*F5     +  0.6359 E35
                  LV35F5
V36     =   0.4696*F6     +  0.8829 E36
                  LV36F6
V37     =   0.6961*F6     +  0.7179 E37
                  LV37F6
V38     =   0.5636*F6     +  0.8261 E38
                  LV38F6
V39     =   0.8017*F6     +  0.5977 E39
                  LV39F6
V40     =   0.7642*F6     +  0.6450 E40
                  LV40F6
V41     =   0.7427*F6     +  0.6696 E41
```

```
                      LV41F6
V42      =    0.7453*F7     +   0.6667 E42
                      LV42F7
V43      =    0.6791*F7     +   0.7340 E43
                      LV43F7
V44      =    0.7829*F7     +   0.6221 E44
                      LV44F7
V45      =   -0.0198*F7     +   0.9998 E45
                      LV45F7
V46      =    0.6793*F7     +   0.7339 E46
                      LV46F7
V47      =    0.6288*F7     +   0.7775 E47
                      LV47F7
V48      =    0.6294*F7     +   0.7770 E48
                      LV48F7
V49      =    0.3322*F7     +   0.9432 E49
                      LV49F7
V50      =    0.1293*F7     +   0.9916 E50
                      LV50F7
V51      =    0.6351*F7     +   0.7724 E51
                      LV51F7
V52      =    0.7076*F7     +   0.7067 E52
                      LV52F7
V53      =    0.5881*F8     +   0.8088 E53
                      LV53F8
V54      =    0.8068*F8     +   0.5909 E54
                      LV54F8
V55      =    0.7521*F8     +   0.6591 E55
                      LV55F8
V56      =    0.6660*F9     +   0.7460 E56
                      LV56F9
V57      =    0.6236*F9     +   0.7817 E57
                      LV57F9
V58      =    0.6256*F9     +   0.7801 E58
                      LV58F9
V59      =    0.6420*F9     +   0.7667 E59
                      LV59F9
V60      =    0.5259*F9     +   0.8505 E60
                      LV60F9
V61      =    0.2883*F9     +   0.9576 E61
                      LV61F9
V62      =    0.8217*F9     +   0.5699 E62
                      LV62F9
V63      =    0.7055*F9     +   0.7087 E63
                      LV63F9
V64      =    0.6828*F9     +   0.7306 E64
                      LV64F9
```

Output 4 gives a summary of the non significant standardized and non standardized factor loadings. Values lower than 0.5 are indicated.

The lowest factor loadings common to both standardized and non standardized data are V45 and V50.

Output 4 Non significant factor loadings: initial measurement model

Indicator variable	Non standardized factor loading	Indicator variable	Standardized factor loading
V16	0.4237	V5	0.3689
V17	0.4803	V13	0.4608
V20	0.2892	V16	0.3986
V26	0.4649	V20	0.2525
V28	0.3671	V28	0.3660
V45	-0.0189	V36	0.4696
V49	0.2507	V45	-0.0198
V50	0.1434	V49	0.3322
V61	0.2519	V50	0.1293

Step 4: Reviewing the residual matrix and normalized residual matrix.

The distribution of normalised residuals is given in Output 5 for the initial measurement model.

Output 5 Distribution of normalised residuals: initial measurement model

```
                    The CALIS Procedure
   Covariance Structure Analysis: Maximum Likelihood Estimation

       Distribution of Asymptotically Standardized Residuals

                Each * Represents 8 Residuals

----------Range---------     Freq    Percent

  -5.50000      -5.25000        1       0.05
  -5.25000      -5.00000        0       0.00
  -5.00000      -4.75000        0       0.00
  -4.75000      -4.50000        0       0.00
  -4.50000      -4.25000        0       0.00
  -4.25000      -4.00000        2       0.10
  -4.00000      -3.75000        0       0.00
```

-3.75000	-3.50000	4	0.19	
-3.50000	-3.25000	9	0.43	*
-3.25000	-3.00000	13	0.63	*
-3.00000	-2.75000	11	0.53	*
-2.75000	-2.50000	18	0.87	**
-2.50000	-2.25000	41	1.97	*****
-2.25000	-2.00000	57	2.74	*******
-2.00000	-1.75000	48	2.31	******
-1.75000	-1.50000	69	3.32	********
-1.50000	-1.25000	98	4.71	************
-1.25000	-1.00000	110	5.29	*************
-1.00000	-0.75000	131	6.30	****************
-0.75000	-0.50000	151	7.26	******************
-0.50000	-0.25000	113	5.43	**************
-0.25000	0	120	5.77	***************
0	0.25000	188	9.04	***********************
0.25000	0.50000	142	6.83	*****************
0.50000	0.75000	126	6.06	***************
0.75000	1.00000	133	6.39	****************
1.00000	1.25000	112	5.38	**************
1.25000	1.50000	82	3.94	**********
1.50000	1.75000	68	3.27	********
1.75000	2.00000	62	2.98	*******
2.00000	2.25000	53	2.55	******
2.25000	2.50000	27	1.30	***
2.50000	2.75000	11	0.53	*
2.75000	3.00000	18	0.87	**
3.00000	3.25000	21	1.01	**
3.25000	3.50000	9	0.43	*
3.50000	3.75000	7	0.34	
3.75000	4.00000	11	0.53	*
4.00000	4.25000	4	0.19	
4.25000	4.50000	4	0.19	
4.50000	4.75000	2	0.10	
4.75000	5.00000	0	0.00	

Hatcher (1994, p. 301) states that a model provides a good fit for the data if the distribution of normalised residuals is (a) centered on zero, (b) symmetrical and (c) contains no or few large residuals. Output 6 indicates that the data is centered on zero and is relatively symmetrical. *The normal distribution of the residuals is an indication that, although the assumption of normality in indicator variables is not displayed, structural equation modelling can still be applied to produce valid findings.*

In addition, the individual normalised residuals are inspected – entries in the residual matrix are expected to be zero or non-zero. A normalised residual is considered a problem when its' absolute value is greater than 2. Output 6 provides a rank order of the ten largest normalized residuals found in the data.

Output 6 Rank order of 10 largest normalized residuals: initial measurement model

Row	Column	Residual
V59	V23	5.82409
V21	V9	5.77379
V56	V29	-5.37137
V63	V37	5.33910
V32	V19	5.03935
V37	V36	4.63169
V46	V44	4.52408
V64	V56	4.43787
V4	V3	4.41270
V15	V14	4.28202

Output 6 indicates that there are large normalized residuals present in the data. For example, a large normalised residual of 5.82 exists between V59 and V23 indicating that there is a difference in the actual and predicted covariance of V59 and V23. There are two possible reasons for large normalized residuals (Hatcher 1994):

(1) An indicator variable is assigned to the wrong factor and would thus demonstrate a large negative normalized residual with the other indicator variables that were correctly assigned to the factor.

(2) An indicator variable is multi-dimensional (also known as a complex item): if the indicator is influenced by more than one factor it will display a large normalized residual.

All the tests above indicate that the initial measurement model does not provide a good fit for the actual data. It is therefore necessary to modify the measurement model to improve the model fit.

5.5.3 Modifying the measurement model

Firstly, the Wald test is used to estimate the change in the model chi-square that would occur if a given parameter is fixed at zero (for example, a covariance is eliminated from the model).

Output 7 gives the results of the Wald test for the initial measurement model.

Output 7 Wald test results: initial measurement model

Stepwise Multivariate Wald Test

	------Cumulative Statistics-----			--Univariate Increment--	
Parameter	Chi-Square	DF	Pr > ChiSq	Chi-Square	Pr > ChiSq
LV45F7	0.04433	1	0.8332	0.04433	0.8332
LV50F7	1.95792	2	0.3757	1.91359	0.1666

The Wald test indicates the following:

- If the path between variable indicator V45 and Factor 7 were removed, the chi-square value would decrease by 0.04433 and the degrees of freedom of the model would increase by 1.
- If, in addition, the path between variable indicator V50 and Factor 7 were removed, the chi-square value would decrease by 1.95792 and the degrees of freedom would increase by 2.

The non significant factor loadings of V45 and V50 confirm these findings: together it indicates that V45 and V50 are not good measures of Factor 7. The test items are reproduced for clarity:

FACTOR 7 RETURN ON INVESTMENT

V45: Environmental management has been a net expense for the firm.

V50: We do not receive revenue from the use of our by-products as raw materials by other firms.

It is interesting to note that the original item 45 was reworded on suggestions from the expert panel. The original item 45 of the research questionnaire read as follows: Environmental management only costs the firm money. The respondents of the expert panel found this statement difficult to interpret and it was consequently changed to: Environmental management has been a net expense for the firm.

Also, the expert panel recommended that all negatively-worded items be removed from the questionnaire. Item V50 is a negatively-worded question. It may be concluded that the research participants did not fully understand the meaning of the above questions V45 and V50 and consequently created bias in their response.

Secondly, the Lagrange multiplier test was used to estimate the degree to which the model chi-square would improve if a new factor loading or covariance were added to the model. The Lagrange multiplier test is given in Output 8.

Output 8 Lagrange Multiplier test indices: initial measurement model

Covariance Structure Analysis: Maximum Likelihood Estimation

Rank Order of the 10 Largest Lagrange Multipliers in _GAMMA_

Row	Column	Chi-Square	Pr > ChiSq
V19	F5	34.27200	<.0001
V35	F4	31.17558	<.0001
V35	F1	28.90867	<.0001
V35	F6	28.84771	<.0001
V11	F9	27.86941	<.0001
V11	F7	26.78523	<.0001
V19	F1	26.23055	<.0001
V35	F9	25.18448	<.0001
V19	F3	23.49318	<.0001
V11	F8	21.81968	<.0001

The data indicates that the model chi-square would decrease by 34.272 if a path is added from V19 to F5. However, chi-square would also improve if V19 is added to F1 and F3. Consequently, V19 is a complex item. Hatcher (1994) states that a complex indicator should be dropped completely rather than assign it to two or more different factors simultaneously.

The current model was modified in 14 iterations until an acceptable model fit was achieved. Each iteration used the tests described above to assess the model fit.

For the following twelve iterations, only the goodness of fit indices are given below. It should be noted, however, that all the requirements listed above were inspected for each iteration.

Iteration 1:

V45 and V50 are dropped from the model.

Goodness of Fit Indices

Chi-square	3410
Degrees of freedom	1793
Ratio of Chi-square to *df*	1.9
GFI	0.54
CFI	0.69
NNFI	0.67
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 2:

V11, V19 and V35 are dropped from the model. The variables showed non significant standardized factor loadings and were identified as complex items in the Lagrange Multiplier test.

Goodness of Fit Indices

Chi-square	2945
Degrees of freedom	1616
Ratio of Chi-square to df	1.82
GFI	0.56

CFI	0.72
NNFI	0.70
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 3:

V5, V20, V28, V49 and V61 are dropped from the model. The variables showed non significant standardized factor loadings and were identified as complex items in the Lagrange Multiplier test.

Goodness of Fit Indices

Chi-square	2423
Degrees of freedom	1341
Ratio of Chi-square to df	1.80
GFI	0.58
CFI	0.76
NNFI	0.74
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 4:

V12 is dropped from the model. It was identified as a complex item in the Lagrange Multiplier test, loading on F2, F7 and F8.

The Lagrange Multiplier also suggested adding a path from:

V43 to F5

V48 to F5

V29 to F9

Before the paths were added, the actual test items were inspected to confirm the above suggestions:

F5 RESOURCE CONSERVATION

V43: The firm has reduced its use of resources, including water, electricity and land, thereby saving input costs.

V48: The firm has achieved significant cost savings by applying life-cycle analysis.

Both these test items measure the cost savings achieved by resource conservation (included in life-cycle analysis) and it therefore made sense to add these paths to factor F5.

F9 COMPETITIVE ADVANTAGE

V29: Our firm conducts environmental impact assessments before commencing construction or activities that may impact on the environment.

The definition of the construct Competitive Advantage (F9) reads as follows:

Construct 9 Competitive Advantage was developed to measure the potential competitive advantage gained by an increase in market share, entry into new markets, creation of barriers-to-market entry, employee commitment, reduction in financial risk and long-term relationships with stakeholders – all potentially gained by the practice of environmental management.

As such, conducting environmental impact assessments creates competitive advantage in the sense that it promotes long-term relationships with stakeholders, including the community and legislators. Therefore a path was added from V29 to F9.

Goodness of Fit Indices

Chi-square	2365
Degrees of freedom	1289
Ratio of Chi-square to df	1.83
GFI	0.59
CFI	0.75
NNFI	0.74
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 5:

The next iteration dropped V29, V48, V56 and V63 from the model. The indicator variables V29 and V48 added as new paths in the previous iteration proved to be poor and resulted in complex items in the Lagrange Multiplier test. The variable V29 also contributed significantly to the top ten normalized residuals.

Goodness of Fit Indices

Chi-square	1890
Degrees of freedom	1091
Ratio of Chi-square to df	1.73
GFI	0.63
CFI	0.79
NNFI	0.77
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 6:

Two complex items, V53 and V54, are dropped from the model (as indicated in the Lagrange Multiplier test).

The complex items V9, V41 and V46 are dropped as well. These items also contributed significantly to the ten largest normalized residuals.
Also, V17, V36 and V60 are dropped from the model. These items displayed low normalized factor loadings and contributed to high normalized residuals.

As a result, factor F8 Intellectual Capital was removed from the model.

Goodness of Fit Indices

Chi-square	1242
Degrees of freedom	751
Ratio of Chi-square to df	1.65
GFI	0.69
CFI	0.84
NNFI	0.83
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 7:

The complex items V18, V37, V44 and V55 are dropped from the model. These items contributed significantly to the ten largest normalized residuals.

Also, V6, V13, V16, V18 and V26 are dropped from the model. These items displayed non significant normalized factor loadings and contributed to high normalized residuals.

Goodness of Fit Indices

Chi-square	810
Degrees of freedom	467

Ratio of Chi-square to df	1.73
GFI	0.74
CFI	0.87
NNFI	0.85
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration does not provide a good fit of the data.

Iteration 8:

The complex items V8, V23, V2, V3 and V22 are dropped from the model. The items contributed significantly to the ten largest normalized residuals.

Goodness of Fit Indices

Chi-square	534
Degrees of freedom	322
Ratio of Chi-square to df	1.66
GFI	0.78
CFI	0.89
NNFI	0.87
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 9:

The complex items V57 and V32 are dropped from the model.

Goodness of Fit Indices

Chi-square	437
Degrees of freedom	271
Ratio of Chi-square to df	1.61

GFI	0.81
CFI	0.91
NNFI	0.87
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the iteration did not provide a good fit of the data.

Iteration 10:

The complex items V25, V51 and V7 are dropped from the model. V51 and V7 contributed significantly to the ten largest normalized residuals.

Goodness of Fit Indices

Chi-square	319
Degrees of freedom	202
Ratio of Chi-square to df	1.57
GFI	0.83
CFI	0.92
NNFI	0.90
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the model fit had improved significantly. The model did, however, still contain normalized residuals with absolute values greater than 2. More iteration was therefore required.

Iteration 11:

The complex item V47 is dropped from the model. As a result, the factor F3 Risk Management is removed from the model.

The Lagrange Multiplier test proposed the addition of the following paths to the model:

V21 to F1

V24 to F1

V38 to F2

V62 to F4

Once again, the actual test items were inspected to confirm the above suggestions:

F1 TOP MANAGEMENT COMMITMENT

V21: We have external, independent environmental audits conducted on our processes.

V24: Environmental regulation is not a major concern for our firm.

F2 PRODUCT & PROCESS TECHNOLOGY

V38: We contain the technical expertise within the firm to modify industrial processes in order to reduce pollution and waste.

F4 STAKEHOLDER PARTNERSHIPS

V62: We have developed strong relationships with stakeholders by communicating environmental performance data.

All the suggestions make sense and the new paths were therefore added.

Goodness of Fit Indices

Chi-square	308
Degrees of freedom	188
Ratio of Chi-square to df	1.64
GFI	0.83
CFI	0.92
NNFI	0.89
Absolute normalized residuals > 2 ?	Yes

The indices indicate that the model fit had improved significantly. The model did, however, still contain normalized residuals with absolute values greater than 2. More iteration was therefore required.

Iteration 12:

The Lagrange Multiplier test indicates that both V38 and V15 are complex items. The items are therefore dropped from the model.

As a result, only V14 is left as an indicator variable for factor F2.

Goodness of Fit Indices

Chi-square	236
Degrees of freedom	149
Ratio of Chi-square to df	1.58
GFI	0.85
CFI	0.9351
NNFI	0.9172
Absolute normalized residuals > 2 ?	No

Iteration 12 met all the goodness of fit criteria for an acceptable model fit.

- The ratio of chi-square to df < 2.
- The GFI > 0.8.
- CFI and NNFI are both > 0.9.
- There are no normalized residuals with absolute values > 2.
- The distribution of normalized residuals meets all the criteria of normal distribution. This is evident from Output 9.

Output 9 Distribution of normalized residuals: iteration 12

```
                                The CALIS Procedure
```

Covariance Structure Analysis: Maximum Likelihood Estimation

Distribution of Normalized Residuals

Each * Represents 3 Residuals

----------Range---------		Freq	Percent	
-1.50000	-1.25000	1	0.48	
-1.25000	-1.00000	3	1.43	*
-1.00000	-0.75000	7	3.33	**
-0.75000	-0.50000	17	8.10	*****
-0.50000	-0.25000	27	12.86	*********
-0.25000	0	50	23.81	****************
0	0.25000	53	25.24	*****************
0.25000	0.50000	24	11.43	********
0.50000	0.75000	13	6.19	****
0.75000	1.00000	8	3.81	**
1.00000	1.25000	4	1.90	*
1.25000	1.50000	0	0.00	
1.50000	1.75000	2	0.95	
1.75000	2.00000	1	0.48	

The following possible problems in the model specification were noted:

- Only one item (V14) is measuring F2.
- Only two items (V42 and V52) are measuring F7.

Before Iteration 12 was accepted as the final measurement model, the discriminant validity of the constructs and indicator variables were calculated.

5.5.4 Discriminant validity

Discriminant validity is demonstrated when the correlations between the different test items which are used to measure different constructs are relatively weak.

The confidence interval test was used to assess the discriminant validity of two factors. The test calculates a confidence interval of plus and minus two standard errors around the correlation between the factors and if this interval includes the value 1, discriminant validity is not demonstrated.

The covariance, standard errors and *t*- values are given in the following table.

Output 10 Covariance among exogenous variables: iteration 12

Var1	Var2	Parameter	Estimate	Standard Error	t Value
F1	F2	CF1F2	0.46522	0.27201	1.71
F1	F4	CF1F4	0.87544	0.18169	4.82
F2	F4	CF2F4	0.54660	0.28013	1.95
F1	F5	CF1F5	0.68294	0.22286	3.06
F2	F5	CF2F5	0.36750	0.21376	1.72
F4	F5	CF4F5	0.76622	0.19645	3.90
F1	F6	CF1F6	0.97409	0.16481	5.91
F2	F6	CF2F6	0.43866	0.26601	1.65
F4	F6	CF4F6	0.87187	0.19528	4.46
F5	F6	CF5F6	0.62679	0.23783	2.64
F1	F7	CF1F7	0.66703	0.27198	2.45
F2	F7	CF2F7	0.54466	0.22977	2.37
F4	F7	CF4F7	0.84098	0.21357	3.94
F5	F7	CF5F7	0.83156	0.17720	4.69
F6	F7	CF6F7	0.74282	0.24503	3.03
F1	F9	CF1F9	0.73555	0.22575	3.26
F2	F9	CF2F9	0.47291	0.21749	2.17
F4	F9	CF4F9	0.86765	0.18516	4.69
F5	F9	CF5F9	0.61642	0.20677	2.98
F6	F9	CF6F9	0.79015	0.20853	3.79
F7	F9	CF7F9	0.93254	0.17571	5.31

Table 10 gives the upper and lower boundaries estimated with the confidence interval test for each covariance. The calculations use the equations listed below:

Upper bound = estimate + 2 standard errors

Lower bound = estimate – 2 standard errors

For example:

Upper bound (CF1F2) = 0.46522 + (2 x 0.27201) = 1.009

Lower bound (CF1F2) = 0.46522 – (2 x 0.27201) = -0.078

The data indicates that only the following factors demonstrate discriminant validity (upper or lower boundaries exclude the value 1):

Factors F2 and F5

Factors F2 and F6

Factors F2 and F9

It is interesting to note that F2 is common factor to the listing above.

Table 10 Discriminant validity: iteration 12

Covariance	Upper boundary	Lower boundary
CF1F2	1.01	-0.08
CF1F4	1.24	0.51
CF2F4	1.11	-0.01
CF1F5	1.13	0.24
CF2F5	0.80	0.80
CF4F5	1.16	0.37
CF1F6	1.30	0.64
CF2F6	0.97	-0.09
CF4F6	1.26	0.48
CF5F6	1.10	0.15
CF1F7	1.21	0.12
CF2F7	1.00	0.09
CF4F7	1.27	0.41
CF5F7	1.19	0.48
CF6F7	1.23	0.25
CF1F9	1.19	0.28
CF2F9	0.91	0.04
CF4F9	1.24	0.50
CF5F9	1.03	0.20
CF6F9	1.21	0.37
CF7F9	1.29	0.58

As a result further data analysis was required to develop an acceptable model fit of the data.

Iteration 13:

From Iteration 12 it was noted that a possible problem in the model specification was that there were only two indicator variables (V42 and V52) measuring factor F7.

According to the interpretability criteria given by Hatcher (1994), a factor should be measured by at least three indicator variables. The variables are reprinted below:

F7 RETURN ON INVESTMENT

V42: Environmental management leads to significant cost advantages for our firm.

V52: Environmental audits have identified opportunities for cost savings within the firm.

Both the test items above suggest cost savings as a result of environmental management practices. The items were removed from factor F7 and new paths created to factor F9 Competitive Advantage. As a result, factor F7 was removed from the model. The results of the iteration indicated that the standardized factor loadings for both variables on F9 were significant and the change was therefore appropriate:

LV42F9 = 0.7622

LV52F9 = 0.6928

Goodness of Fit Indices

Chi-square	251
Degrees of freedom	155
Ratio of Chi-square to df	1.62
GFI	0.844
CFI	0.9284
NNFI	0.9123
Absolute normalized residuals > 2 ?	No

The goodness-of-fit indices indicate an acceptable model fit. The distribution of normalized residuals shows that the shape is asymmetrical with four outlier residuals in one tail of the distribution. The distribution is given in Output 11.

Output 11 Distribution of normalized residuals: iteration 13

```
                    Distribution of Normalized Residuals

                       Each * Represents 2 Residuals

----------Range---------     Freq    Percent

  -1.50000     -1.25000        1       0.48
  -1.25000     -1.00000        4       1.90    **
  -1.00000     -0.75000        9       4.29    ****
  -0.75000     -0.50000       17       8.10    ********
  -0.50000     -0.25000       26      12.38    *************
  -0.25000            0       50      23.81    *************************
         0      0.25000       48      22.86    ************************
   0.25000      0.50000       29      13.81    **************
   0.50000      0.75000       13       6.19    ******
   0.75000      1.00000        6       2.86    ***
   1.00000      1.25000        1       0.48
   1.25000      1.50000        2       0.95    *
   1.50000      1.75000        1       0.48
   1.75000      2.00000        3       1.43    *
```

Once again the discriminant validity was calculated for the model. The results are given in Table 11.

The results in Table 11 indicate that factors F1 and F6 do not display discriminant validity. The original definitions of the constructs are reproduced below.

Table 11 Discriminant validity: iteration 13

Covariance	Estimation	Std Error	Upper Bound	Lower Bound
CF1F2	0.467	0.072	0.611	0.323
CF1F4	0.875	0.039	0.953	0.797
CF2F4	0.549	0.062	0.673	0.425
CF1F5	0.680	0.068	0.816	0.544
CF2F5	0.368	0.082	0.532	0.204
CF4F5	0.768	0.055	0.878	0.658
CF1F6	0.974	0.035	1.044	0.904
CF2F6	0.441	0.077	0.595	0.287

CF4F6	0.872	0.045	0.962	0.782
CF5F6	0.627	0.077	0.781	0.473
CF1F9	0.716	0.064	0.844	0.588
CF2F9	0.525	0.068	0.661	0.389
CF4F9	0.874	0.041	0.956	0.792
CF5F9	0.742	0.062	0.866	0.618
CF6F9	0.779	0.059	0.897	0.661

F1 TOP MANAGEMENT COMMITMENT

Construct 1 Top Management Commitment measures the extent to which top management recognizes the importance of environmental issues facing the firm and the integration of those issues into the firm's strategic and operational plans.

F6 EMPLOYEE RELATIONS

Construct 6 Employee Relations measures the extent to which employees remain committed to the firm by sharing with it the core value environmental management, the extent to which the firm contains environmental management skills and the extent to which employees are involved in environmental management within the firm.

It is possible that the construct Employee Relations may be absorbed by the construct Top Management Commitment, in that top management of firms determines the *extent to which the firm contains environmental management skills and the extent to which employees are involved in environmental management within the firm (adopted from the original definition of Employee Relations).*

Only two items, V39 and V40, are measuring the factor Employee Relations. These items are reproduced below:

F6 EMPLOYEE RELATIONS

V39: Key personnel are appointed for environmental issues.

V40: We provide environmental management training for our employees.

The two indicator variables strongly show that top management is the determinant of employee relations as defined in this study (it is top management that appoints personnel and top management that provides training for personnel). This analysis therefore supports the discriminant validity test that items V39 and V40 should load on factor F1. As a result factor F6 is removed from the model.

Iteration 14:

V39 and V40 are loaded on factor F1.

Output 12 provides the goodness of fit statistics for the confirmatory factor analysis iteration 14. The SAS PROC CALIS program is given in Appendix H.

5.5.5 Final revised measurement model

Output 12 Goodness of fit statistics: final revised measurement model

```
                     The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function                                          2.0844
Goodness of Fit Index (GFI)                           0.8429
GFI Adjusted for Degrees of Freedom (AGFI)            0.7938
Root Mean Square Residual (RMR)                       0.0578
Parsimonious GFI (Mulaik, 1989)                       0.7098
Chi-Square                                          256.3752
Chi-Square DF                                            160
Pr > Chi-Square                                       <.0001
Independence Model Chi-Square                         1533.7
Independence Model Chi-Square DF                         190
RMSEA Estimate                                        0.0700
RMSEA 90% Lower Confidence Limit                      0.0536
RMSEA 90% Upper Confidence Limit                      0.0856
ECVI Estimate                                         3.0647
ECVI 90% Lower Confidence Limit                       2.7326
ECVI 90% Upper Confidence Limit                       3.4763
Probability of Close Fit                              0.0241
Bentler's Comparative Fit Index                       0.9283
Normal Theory Reweighted LS Chi-Square              229.2176
Akaike's Information Criterion                      -63.6248
Bozdogan's (1987) CAIC                             -674.8699
Schwarz's Bayesian Criterion                       -514.8699
```

McDonald's (1989) Centrality	0.6780
Bentler & Bonett's (1980) Non-normed Index	0.9148
Bentler & Bonett's (1980) NFI	0.8328
James, Mulaik, & Brett (1982) Parsimonious NFI	0.7013
Z-Test of Wilson & Hilferty (1931)	4.6036
Bollen (1986) Normed Index Rho1	0.8015
Bollen (1988) Non-normed Index Delta2	0.9298
Hoelter's (1983) Critical N	93

The table indicates a ratio of chi-square to *df* of 1.60 and a goodness of fit index of 0.8429. In addition, CFI and NNFI are both greater than 0.9.

The ten largest standardized normalized residuals are given in Output 13. There are no absolute values greater than 2.

Output 13 Rank order of the 10 largest normalized residuals: final revised measurement model

Row	Column	Residual
V40	V31	1.86383
V43	V42	1.83532
V34	V10	1.80702
V58	V21	1.79491
V58	V39	1.53864
V42	V31	-1.36810
V58	V34	-1.22187
V59	V10	1.19847
V59	V58	1.18595
V59	V34	-1.17883

The distribution of normalized residuals is shown in Output 14. The distribution is centered on zero, but shows an asymmetrical distribution.

Output 14 Distribution of normalized residuals: final revised measurement model

Each * Represents 3 Residuals

----------Range---------		Freq	Percent	
-1.50000	-1.25000	1	0.48	
-1.25000	-1.00000	4	1.90	*
-1.00000	-0.75000	11	5.24	***
-0.75000	-0.50000	13	6.19	****
-0.50000	-0.25000	27	12.86	*********
-0.25000	0	45	21.43	***************
0	0.25000	55	26.19	******************

0.25000	0.50000	26	12.38	********
0.50000	0.75000	16	7.62	*****
0.75000	1.00000	4	1.90	*
1.00000	1.25000	3	1.43	*
1.25000	1.50000	0	0.00	
1.50000	1.75000	1	0.48	
1.75000	2.00000	4	1.90	*

Output 15 gives the standardized factor loadings of iteration 14. **Note**: analysis of the non standardized factor loadings indicated that V14 displays a zero standard error – this creates an estimation problem and shows that V14 is linearly dependent on other parameters in the model. Currently, the model is simulated as a standard model: a model in which all factors are measured by more than one indicator variable. Since factor F2 is measured completely by only one variable V14 (as seen in the standardized factor loading LV14F2 = 1.0050 in Output 15), the model should in fact be programmed as a non-standard model. Attempts to model a non-standard model did not improve the model fit and the researcher *proceeded data analysis with the current standard model*. V14 is possibly the reason for the asymmetrical shape of the distribution in Output 14. The researcher expects that all following distributions will have a similar shape. The factor and variable are given below:

F2 PRODUCT & PROCESS TECHNOLOGY

V14: Our firm designs new products to minimize the product's environmental impact.

All *t*-values were > 1.96 and therefore significant at a 95% confidence level. All factor loadings were higher than 0.6 and therefore significant.

Output 15 Standardized factor loadings: final revised measurement model

```
V1    =   0.6296*F1    +  0.7769 E1
              LV1F1
V4    =   0.8026*F1    +  0.5965 E4
              LV4F1
V10   =   0.6976*F1    +  0.7165 E10
              LV10F1
V14   =   1.0050*F2    +  1.0000 E14
              LV14F2
```

```
V21     =   0.7188*F1    +  0.6952 E21
                LV21F1
V24     =   0.6654*F1    +  0.7465 E24
                LV24F1
V27     =   0.7771*F4    +  0.6293 E27
                LV27F4
V30     =   0.8461*F4    +  0.5330 E30
                LV30F4
V31     =   0.6032*F4    +  0.7976 E31
                LV31F4
V33     =   0.8058*F5    +  0.5922 E33
                LV33F5
V34     =   0.7798*F5    +  0.6260 E34
                LV34F5
V39     =   0.8520*F1    +  0.5236 E39
                LV39F1
V40     =   0.7539*F1    +  0.6569 E40
                LV40F1
V42     =   0.7534*F9    +  0.6576 E42
                LV42F9
V43     =   0.7498*F5    +  0.6617 E43
                LV43F5
V52     =   0.6981*F9    +  0.7160 E52
                LV52F9
V58     =   0.6010*F9    +  0.7993 E58
                LV58F9
V59     =   0.6516*F9    +  0.7586 E59
                LV59F9
V62     =   0.8350*F4    +  0.5503 E62
                LV62F4
V64     =   0.7084*F9    +  0.7058 E64
               LV64F9
```

The Wald test (Output 16) indicated that the removal of VARE14 would increase the model chi-square by 0.109. The value is insignificant and therefore ignored.

Output 16 Wald test results: final revised measurement model

Stepwise Multivariate Wald Test

	------Cumulative Statistics-----			--Univariate Increment--	
Parameter	Chi-Square	DF	Pr > ChiSq	Chi-Square	Pr > ChiSq
VARE14	0.10913	1	0.7411	0.10913	0.7411

Finally, the reliability and discriminant validity of the constructs and indicators were calculated.

Composite reliability

The reliability of an indicator variable is defined as the square of the correlation between a latent factor and the indicator – it therefore indicates the percent of variation in the indicator that is explained by the factor (Hatcher 1994, p.325).

The **composite reliability index** reflects the internal consistency of the indicators measuring a given factor. It is analogous to the Cronbach's coefficient alpha and is calculated as follows:

$$\text{Composite Reliability Index} = \frac{(\sum L_i)^2}{(\sum L_i)^2 + \sum Var(E_i)} \quad \text{......................} \textbf{\textit{Equation 5}}$$

Where:

L_i = standardized factor loadings for that factor

$Var\ (E_i)$ = the error variance associated with the individual indicator variables.

The minimally acceptable level of composite reliability for an instrument is 0.70.

Variance extracted estimate

The **variance extracted estimate** assesses the amount of variance that is captured by an underlying factor in relation to the amount of variance due to measurement error. The formula is given below:

$$\text{Variance extracted estimate} = \frac{\sum L_i^{\,2}}{\sum L_i^{\,2} + \sum Var(E_i)} \quad \text{..........................} \textbf{\textit{Equation 6}}$$

The composite reliability indices and the variance extracted estimates for the final revised measurement model is given in Table 12.

Table 12 Properties of the final revised measurement model

Construct and Indicators	Standardized Loading	t[7]	Reliability	Variance Extracted Estimate
Top Management Commitment (F1)			**0.89**[8]	**0.54**
V1	0.6296	7.5317	0.3964	
V4	0.8026	10.4986	0.6442	
V10	0.6979	8.6077	0.4867	
V21	0.7188	8.9639	0.5167	
V24	0.6654	8.0862	0.4428	
V39	0.8520	11.5121	0.7258	
V40	0.7539	9.5818	0.5684	
Process and Product Technology (F2)			**1.0**	**1.0**
V14	1.005	16.3867	1.01	
Stakeholder Partnerships (F4)			**0.85**	**0.60**
V27	0.7771	10.0258	0.6040	
V30	0.8461	11.3946	0.7159	
V31	0.6032	7.1560	0.3638	
V62	0.8350	11.1632	0.6972	
Resource Conservation			**0.82**	**0.61**

[7] All t tests were significant at $p < 0.001$
[8] Denotes composite reliability.

(F5)				
V33	0.8058	10.0625	0.6493	
V34	0.7798	9.6202	0.6081	
V43	0.7498	9.1198	0.5622	
Construct and Indicators	**Standardized Loading**	**t**[9]	**Reliability**	**Variance Extracted Estimate**
Competitive Advantage (F9)			**0.814**	**0.47**
V42	0.7534	9.3291	0.5676	
V52	0.6981	8.4106	0.4874	
V58	0.6010	6.9436	0.3612	
V59	0.6516	7.6862	0.4246	
V64	0.7084		0.5018	

The table indicates that five factors remain in the final revised measurement model and **all composite reliabilities are greater than 0.80 (significant).**

The variance extracted estimates for all factors are greater than 0.50, except in the case of factor F9 where the estimate = 0.47. This implies that 47% of the variance is captured by the construct Competitive Advantage and that 53% of the variance is due to measurement error.

Discriminant validity

Table 13 provides the data of discriminant validity for the final revised measurement model. The data shows that all factors demonstrate discriminant validity because no

[9] All t tests were significant at $p < 0.001$

values in the upper and lower bounds exceed the value of 1. (All *t*-values exceed 1.96).

Table 13 Discriminant validity of the final revised measurement model

Covariance	Estimation	Std Error	Upper Bound	Lower Bound
CF1F2	0.461	0.0708	0.604	0.320
CF1F4	0.881	0.0337	0.949	0.814
CF2F4	0.551	0.0632	0.678	0.425
CF1F5	0.662	0.0661	0.794	0.529
CF2F5	0.368	0.0832	0.535	0.202
CF4F5	0.768	0.0552	0.879	0.657
CF1F9	0.750	0.0555	0.861	0.639
CF2F9	0.527	0.0692	0.666	0.389
CF4F9	0.874	0.0410	0.957	0.793
CF5F9	0.740	0.0625	0.866	0.616

Hatcher (1994, p. 339) gives nine conditions which must be met for a measurement model to provide an ideal fit to the data. The conditions are given below.

1. The *p* value for the model chi-square test should be non significant. In the present model the *p* value is <0.0001 which is highly significant. Hatcher (1994) does, however, argue that it is not possible to achieve non significant *p* values for real-life data and that a significant *p* value is not reason enough to reject a model.

2. The chi-square / *df* ratio should be less than 2. This criterion is met by the current model since the ratio = 1.60.

3. The CFI and NNFI should both exceed 0.90. This criterion is met by the current model.

4. The absolute value of the *t* statistics for each factor loadings should exceed 1.96. The criterion is met.

5. The standardized factor loadings should be significant. All standardized factor loadings for the current model are greater than 0.60.

3 The distribution of normalized residuals should be symmetrical and centered on zero and relatively few normalized residuals should exceed an absolute value of 2. For the current model the distribution is centered on zero but the shape is slightly asymmetrical. There are no normalized residuals with an absolute value greater than 2.

4 Composite reliabilities for the latent factors should exceed 0.70. All composite reliabilities of the current model exceed 0.80.

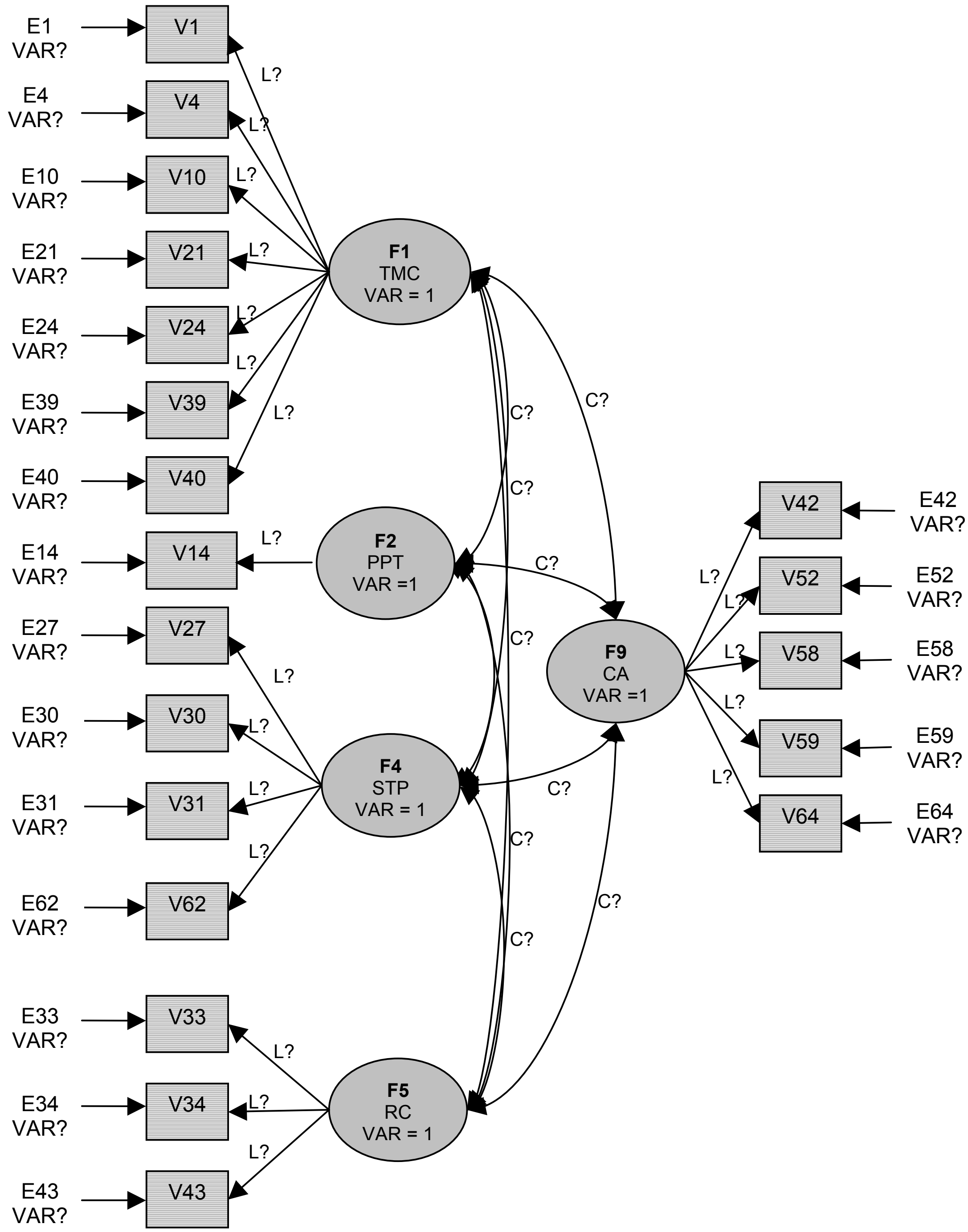
5 Variance extracted estimates for the latent factors should exceed 0.50. Only one factor does not meet this criterion with a variance extracted estimate = 0.47.

6 Discriminant validity should be demonstrated. This criterion is met by the current model.

Iteration 14 was therefore selected as the final revised measurement model. The researcher noted that the distribution of normalized residuals is not symmetrical – two additional iterations, however, did not improve the model fit (V14 was removed from the model and V14 was added to the factor F1).

The final revised measurement model is given in Figure 22.

Figure 22 Final revised measurement model of Environmental Management and Profitability



5.6 Path Analysis with Latent Variables

The final revised measurement model given in Figure 22 is a factor-analytical model which was used to identify the latent constructs and the observed variables that measure each latent construct. Causal relationships were not specified and as such, each construct was allowed to covary with every other construct.

In the two-step approach to path analysis with latent variables, the first step is to modify the measurement model in order to specify causal relationships between some of the latent variables. This becomes the theoretical causal model that will be tested. The theoretical model consists of two components:

- A measurement model that specifies the relationships between the latent constructs.
- A structural model that specifies causal relationships between the latent constructs.

The second step involves the modification of the theoretical model to provide an acceptable and parsimonious fit to the data.

5.6.1 Initial theoretical causal model

Figure 23 gives the initial theoretical causal model to be studied. The SAS PROC CALIS program is attached as Appendix J. The following differences are noted when compared to the measurement model:

1. The initial theoretical model includes the following causal relationships:

   F2 → F9

   F1 → F9

   F4 → F9

F5 → F9

In other words, factors F2 Product & Process Technology, F1 Top Management Commitment, F4 Stakeholder Partnerships and F5 Resource Conservation exert causal influence on the factor F9 Competitive Advantage.

The symbol P? denotes the causal path coefficient between the factors.

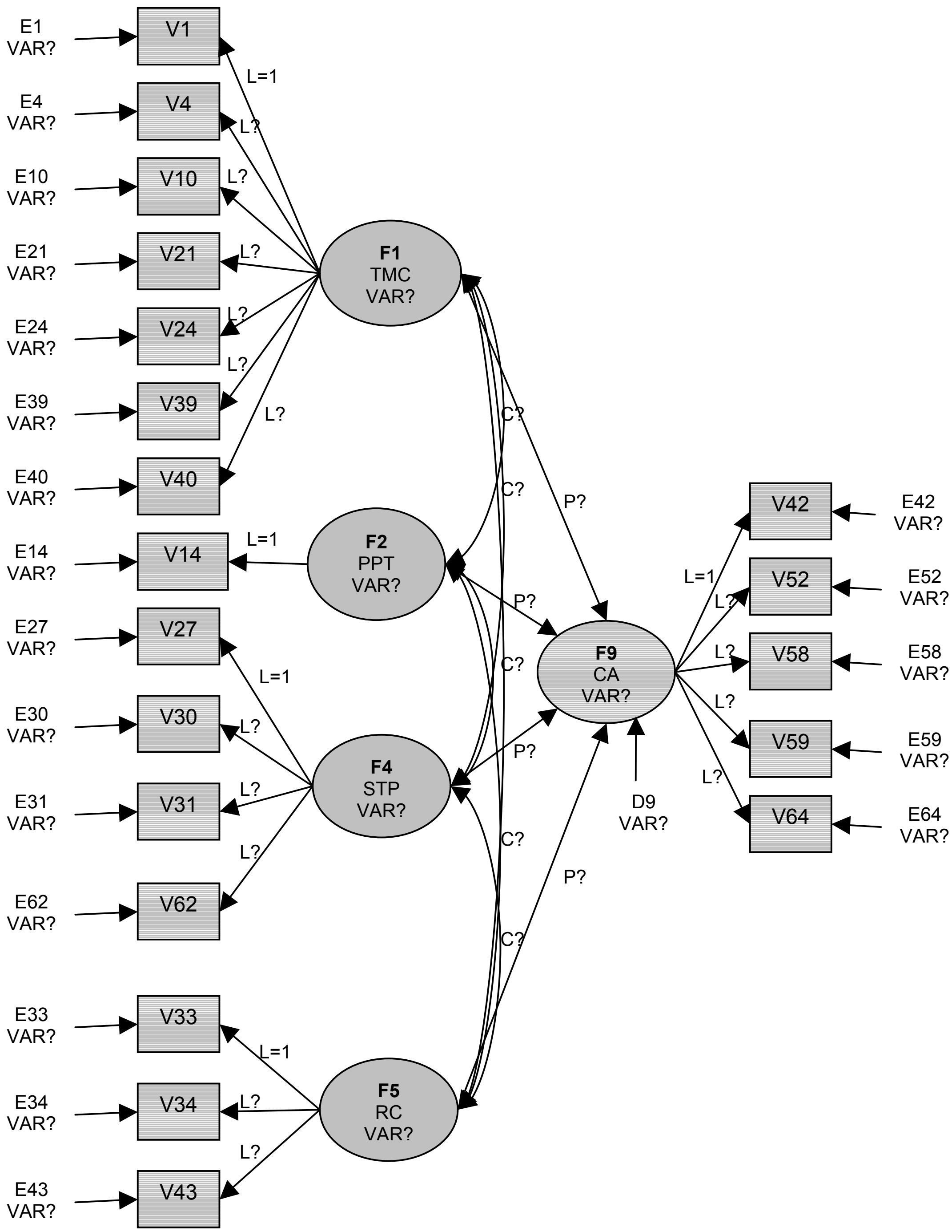
2. The variance of the factors must now be estimated; this is indicated by the symbol VAR? (in the measurement model, the variance of the factors was fixed at 1).

3. The path loading of one manifest variable for each factor has been fixed at 1. Thus:

   LV1F1 = 1
   LV14F2 = 1
   LV27V4 = 1
   LV33F5 = 1
   LV42F9 = 1

4. A residual error term has been added to the endogenous variable factor 9 and its variance must be estimated (indicated by the symbol D9 VAR?).

Figure 23 Initial theoretical model


E1 VAR?
V1
E4 VAR?
V4
E10 VAR?
V10
E21 VAR?
V21
E24 VAR?
V24
E39 VAR?
V39
E40 VAR?
V40
E14 VAR?
V14
E27 VAR?
V27
E30 VAR?
V30
E31 VAR?
V31
E62 VAR?
V62
E33 VAR?
V33
E34 VAR?
V34
E43 VAR?
V43
L=1
L?
F1 TMC VAR?
F2 PPT VAR?
F4 STP VAR?
F5 RC VAR?
F9 CA VAR?
C?
P?
D9 VAR?
V42
E42 VAR?
V52
E52 VAR?
V58
E58 VAR?
V59
E59 VAR?
V64
E64 VAR?

5.6.2 Assessing the fit between model and data

Output 17 provides the goodness of fit statistics for the theoretical model.

Output 17 Goodness of fit statistics: theoretical model

```
                 The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function                                           2.0844
Goodness of Fit Index (GFI)                            0.8429
GFI Adjusted for Degrees of Freedom (AGFI)             0.7938
Root Mean Square Residual (RMR)                        0.0578
Parsimonious GFI (Mulaik, 1989)                        0.7098
Chi-Square                                           256.3752
Chi-Square DF                                             160
Pr > Chi-Square                                        <.0001
Independence Model Chi-Square                          1533.7
Independence Model Chi-Square DF                          190
RMSEA Estimate                                         0.0700
RMSEA 90% Lower Confidence Limit                       0.0536
RMSEA 90% Upper Confidence Limit                       0.0856
ECVI Estimate                                          3.0647
ECVI 90% Lower Confidence Limit                        2.7326
ECVI 90% Upper Confidence Limit                        3.4763
Probability of Close Fit                               0.0241
Bentler's Comparative Fit Index                        0.9283
Normal Theory Reweighted LS Chi-Square               229.2119
Akaike's Information Criterion                       -63.6248
Bozdogan's (1987) CAIC                              -674.8699
Schwarz's Bayesian Criterion                        -514.8699
McDonald's (1989) Centrality                           0.6780
Bentler & Bonett's (1980) Non-normed Index             0.9148
Bentler & Bonett's (1980) NFI                          0.8328
James, Mulaik, & Brett (1982) Parsimonious NFI         0.7013
Z-Test of Wilson & Hilferty (1931)                     4.6036
Bollen (1986) Normed Index Rho1                        0.8015
Bollen (1988) Non-normed Index Delta2                  0.9298
Hoelter's (1983) Critical N                                93
```

Step 1: Reviewing the chi-square test

Chi-square = 256.37 and *df* = 160 with Pr > chi-square <0.0001

Ratio of Chi-square to *df* = 1.60.

Step 2: Reviewing the GFI, NNFI and CFI

GFI = 0.8429

CFI = 0.9283

NNFI = 0.9148

All the values are acceptable.

Step 3: Reviewing the significance tests for factor loadings and path coefficients

Output 18 provides the standard errors, *t*-values and non-standardized factor loadings for the theoretical model. The data indicates that V14 has a standard error of zero and all *t*-values are significant at a 95% confidence level ($t > 1.96$).

Output 18 Non-standardized factor loadings: theoretical model

```
                    The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

         Manifest Variable Equations with Estimates


        V1       =   1.0000 F1       +  1.0000 E1
        V4       =   1.4557*F1       +  1.0000 E4
        Std Err      0.1988 LV4F1
        t Value      7.3227
        V10      =   1.6803*F1       +  1.0000 E10
        Std Err      0.2552 LV10F1
        t Value      6.5854
        V14      =   1.0000 F2       +  1.0000 E14
        V21      =   1.5950*F1       +  1.0000 E21
        Std Err      0.2366 LV21F1
        t Value      6.7409
        V24      =   1.4099*F1       +  1.0000 E24
        Std Err      0.2223 LV24F1
        t Value      6.3437
        V27      =   1.0000 F4       +  1.0000 E27
        V30      =   1.1400*F4       +  1.0000 E30
        Std Err      0.1115 LV30F4
        t Value     10.2273
        V31      =   0.8062*F4       +  1.0000 E31
        Std Err      0.1179 LV31F4
        t Value      6.8404
        V33      =   1.0000 F5       +  1.0000 E33
        V34      =   0.8331*F5       +  1.0000 E34
        Std Err      0.0962 LV34F5
        t Value      8.6572
        V39      =   1.8455*F1       +  1.0000 E39
        Std Err      0.2416 LV39F1
        t Value      7.6375
        V40      =   1.6402*F1       +  1.0000 E40
        Std Err      0.2346 LV40F1
        t Value      6.9916
        V42      =   1.0000 F9       +  1.0000 E42
```

```
V43      =   0.8724*F5       +  1.0000 E43
Std Err      0.1048 LV43F5
t Value      8.3226
V52      =   0.8552*F9       +  1.0000 E52
Std Err      0.1138 LV52F9
t Value      7.5168
V58      =   0.6460*F9       +  1.0000 E58
Std Err      0.1007 LV58F9
t Value      6.4178
V59      =   0.8741*F9       +  1.0000 E59
Std Err      0.1251 LV59F9
t Value      6.9882
V62      =   1.0416*F4       +  1.0000 E62
 Std Err      0.1035 LV62F4
t Value     10.0603
V64      =   0.7251*F9       +  1.0000 E64
Std Err      0.0950 LV64F9
t Value      7.6334
```

Output 19 gives the standardized factor loadings for the theoretical model.

Output 19 Standardized factor loadings: theoretical model

```
                 The CALIS Procedure
  Covariance Structure Analysis: Maximum Likelihood Estimation

    Manifest Variable Equations with Standardized Estimates


        V1      =   0.6296 F1     +  0.7769 E1
        V4      =   0.8026*F1     +  0.5965 E4
                           LV4F1
        V10     =   0.6976*F1     +  0.7165 E10
                           LV10F1
        V14     =   0.9864 F2     +  0.1646 E14
        V21     =   0.7188*F1     +  0.6952 E21
                           LV21F1
        V24     =   0.6655*F1     +  0.7464 E24
                           LV24F1
        V27     =   0.7772 F4     +  0.6293 E27
        V30     =   0.8461*F4     +  0.5330 E30
                           LV30F4
        V31     =   0.6032*F4     +  0.7976 E31
                           LV31F4
        V33     =   0.8058 F5     +  0.5923 E33
        V34     =   0.7798*F5     +  0.6260 E34
                           LV34F5
        V39     =   0.8520*F1     +  0.5236 E39
                           LV39F1
        V40     =   0.7540*F1     +  0.6569 E40
                           LV40F1
        V42     =   0.7534 F9     +  0.6575 E42
        V43     =   0.7498*F5     +  0.6617 E43
                           LV43F5
        V52     =   0.6982*F9     +  0.7159 E52
                           LV52F9
        V58     =   0.6010*F9     +  0.7993 E58
                           LV58F9
        V59     =   0.6516*F9     +  0.7586 E59
```

```
                         LV59F9
V62      =   0.8350*F4     +  0.5503 E62
                         LV62F4
V64      =   0.7084*F9     +  0.7058 E64
                         LV64F9

F9       =  -0.1108*F1      +  0.0620*F2      +  0.8136*F4      +  0.1736*F5
Std Err      0.3182 PF9F1      0.0687 PF9F2      0.3164 PF9F4      0.1397 PF9F5
t Value     -0.3483            0.9036            2.5716            1.2427

                           +  1.0000 D9
```

The final part of Output 19 represents the structural equation part of the theoretical model. It is evident that the only significant factor loading is PF9F4 = 0.8136. Also, all *t*-values are non-significant (<1.96) except for the causal relationship between F4 and F9 where the *t*-value = 2.57.

This provides evidence that the suggested causal model does not provide a good fit for the data.

Step 4: Reviewing R^2 values for latent endogenous variables

Output 20 provides the R^2 values for the latent endogenous variables. The data in the last row of the table indicates that the independent F variable (F9 Competitive Advantage) accounts for 78% of the variance in Competitive Advantage.

Output 20 R^2 values for latent variables: theoretical model

Squared Multiple Correlations

	Variable	Error Variance	Total Variance	R-Square
1	V1	0.45695	0.75711	0.3965
2	V4	0.35137	0.98740	0.6441
3	V10	0.89399	1.74150	0.4867
4	V14	0.03166	1.16895	0.9729
5	V21	0.71427	1.47784	0.5167
6	V24	0.75065	1.34734	0.4429
7	V27	0.39988	1.00981	0.6040
8	V30	0.31460	1.10730	0.7159
9	V31	0.69317	1.08962	0.3638
10	V33	0.39057	1.11347	0.6492
11	V34	0.32334	0.82506	0.6081
12	V39	0.38618	1.40849	0.7258
13	V40	0.61297	1.42044	0.5685
14	V42	0.53420	1.23557	0.5676

15	V43	0.42851	0.97874	0.5622
16	V52	0.53946	1.05242	0.4874
17	V58	0.51773	0.81042	0.3612
18	V59	0.72638	1.26224	0.4245
19	V62	0.28742	0.94911	0.6972
20	V64	0.36606	0.73485	0.5019
21	F9	0.15261	0.70137	0.7824

Step 5: Reviewing the residual matrix and normalized residual matrix

Output 21 gives the distribution of normalized residuals of the theoretical model. If the model provides good fit for the data the distribution should be centered on zero and symmetrical. The diagram indicates that the distribution is centered on zero but still asymmetrical.

Output 21 Distribution of normalized residuals: theoretical model

Each * Represents 2 Residuals

----------Range---------		Freq	Percent	
-1.50000	-1.25000	1	0.48	
-1.25000	-1.00000	4	1.90	**
-1.00000	-0.75000	12	5.71	******
-0.75000	-0.50000	12	5.71	******
-0.50000	-0.25000	27	12.86	*************
-0.25000	0	51	24.29	*************************
0	0.25000	49	23.33	************************
0.25000	0.50000	26	12.38	*************
0.50000	0.75000	16	7.62	********
0.75000	1.00000	4	1.90	**
1.00000	1.25000	3	1.43	*
1.25000	1.50000	0	0.00	
1.50000	1.75000	1	0.48	
1.75000	2.00000	4	1.90	**

The top ten normalized residuals all have absolute values lower than 2. This is indicated in Output 22.

Output 22 Rank order of top 10 normalized residuals: theoretical model

Rank Order of the 10 Largest Normalized Residuals

Row	Column	Residual
V40	V31	1.86358
V43	V42	1.83458
V34	V10	1.80703
V58	V21	1.79494
V58	V39	1.53892
V42	V31	-1.36859
V58	V34	-1.22194
V59	V10	1.19877
V59	V58	1.18613
V59	V34	-1.17875

Step 6: Reviewing the Wald Test

The Wald Test given below indicates that the chi-square of the theoretical model would improve if the causal relationship between factors F9 and F5 were removed.

Output 23 Wald test results: theoretical model

Stepwise Multivariate Wald Test

	------Cumulative Statistics-----			--Univariate Increment--	
Parameter	Chi-Square	DF	Pr > ChiSq	Chi-Square	Pr > ChiSq
PF9F5	2.88474	4	0.5773	1.57938	0.2089

5.6.3 Modifying the theoretical model

The results of the path analysis indicated that the theoretical model does not provide a good fit for the data. Three additional iterations were performed to improve the model fit.

Modification 1:

The factor loading of F1 on F9 was negative and non significant and therefore, the causal relationship between F1 and F9 is removed.

The goodness of fit indices are given below:

Output 24 Goodness of fit indices: modification 1

```
Fit Function                                          2.0853
  Goodness of Fit Index (GFI)                           0.8425
  GFI Adjusted for Degrees of Freedom (AGFI)            0.7946
  Root Mean Square Residual (RMR)                       0.0578
  Parsimonious GFI (Mulaik, 1989)                       0.7139
  Chi-Square                                          256.4975
  Chi-Square DF                                            161
  Pr > Chi-Square                                       <.0001
  Independence Model Chi-Square                         1533.7
  Independence Model Chi-Square DF                         190
  RMSEA Estimate                                        0.0694
  RMSEA 90% Lower Confidence Limit                      0.0531
  RMSEA 90% Upper Confidence Limit                      0.0850
  ECVI Estimate                                         3.0461
  ECVI 90% Lower Confidence Limit                       2.7145
  ECVI 90% Upper Confidence Limit                       3.4571
  Probability of Close Fit                              0.0271
  Bentler's Comparative Fit Index                       0.9289
  Normal Theory Reweighted LS Chi-Square              229.9268
  Akaike's Information Criterion                      -65.5025
  Bozdogan's (1987) CAIC                             -680.5678
  Schwarz's Bayesian Criterion                       -519.5678
  McDonald's (1989) Centrality                          0.6804
  Bentler & Bonett's (1980) Non-normed Index            0.9161
  Bentler & Bonett's (1980) NFI                         0.8328
  James, Mulaik, & Brett (1982) Parsimonious NFI        0.7057
  Z-Test of Wilson & Hilferty (1931)                    4.5574
  Bollen (1986) Normed Index Rho1                       0.8026
  Bollen (1988) Non-normed Index Delta2                 0.9304
  Hoelter's (1983) Critical N                               93
```

Once again, the overall goodness of fit indices for the model are acceptable, with values on the NNFI and CFI in excess of 0.90.

Output 25 gives the distribution of normalized residuals for the first modification. The shape is asymmetrical.

Output 25 Distribution of normalized residuals: modification 1

```
                    Distribution of Normalized Residuals

                       Each * Represents 2 Residuals

----------Range---------    Freq    Percent
```

-1.50000	-1.25000	2	0.95	*
-1.25000	-1.00000	3	1.43	*
-1.00000	-0.75000	12	5.71	******
-0.75000	-0.50000	16	7.62	********
-0.50000	-0.25000	25	11.90	************
-0.25000	0	52	24.76	**************************
0	0.25000	49	23.33	************************
0.25000	0.50000	22	10.48	***********
0.50000	0.75000	15	7.14	*******
0.75000	1.00000	6	2.86	***
1.00000	1.25000	3	1.43	*
1.25000	1.50000	1	0.48	
1.50000	1.75000	1	0.48	
1.75000	2.00000	3	1.43	*

The following output indicates that the factor loadings of F2 and F5 on F9 are non significant.

Output 26 Non-standardized factor loadings: modification 1

```
F9        =   0.0677*F2       +  0.7240*F4       +  0.1869*F5       +  1.0000 D9
Std Err       1.4654 PF9F2       1.2999 PF9F4       0.2557 PF9F5
t Value       0.0462             0.5570             0.7309
```

The Wald Test indicates that the model chi-square will improve if the causal paths from F2 and F5 on F9 were removed.

Output 27 Wald test results: modification 1

Stepwise Multivariate Wald Test

	------Cumulative Statistics-----			--Univariate Increment--	
Parameter	Chi-Square	DF	Pr > ChiSq	Chi-Square	Pr > ChiSq
VARE14	1.62754E-6	1	0.9990	1.62754E-6	0.9990
PF9F2	1.02970	2	0.5976	1.02970	0.3102
PF9F5	2.54017	3	0.4681	1.51047	0.2191

Modification 2:

The factor loading of F2 on F9 was non significant and the Wald Test indicated that, if the causal path were removed, the model chi-square would improve. Therefore, the causal relationship between F2 and F9 is removed in modification 2.

The goodness of fit indices are given below:

Output 28 Goodness of fit indices: modification 2

```
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function                                              2.0938
Goodness of Fit Index (GFI)                               0.8421
GFI Adjusted for Degrees of Freedom (AGFI)                0.7953
Root Mean Square Residual (RMR)                           0.0580
Parsimonious GFI (Mulaik, 1989)                           0.7180
Chi-Square                                              257.5431
Chi-Square DF                                                162
Pr > Chi-Square                                           <.0001
Independence Model Chi-Square                             1533.7
Independence Model Chi-Square DF                             190
RMSEA Estimate                                            0.0692
RMSEA 90% Lower Confidence Limit                          0.0529
RMSEA 90% Upper Confidence Limit                          0.0848
ECVI Estimate                                             3.0350
ECVI 90% Lower Confidence Limit                           2.7029
ECVI 90% Upper Confidence Limit                           3.4465
Probability of Close Fit                                  0.0281
Bentler's Comparative Fit Index                           0.9289
Normal Theory Reweighted LS Chi-Square                  230.6205
Akaike's Information Criterion                          -66.4569
Bozdogan's (1987) CAIC                                 -685.3425
Schwarz's Bayesian Criterion                           -523.3425
McDonald's (1989) Centrality                              0.6803
Bentler & Bonett's (1980) Non-normed Index                0.9166
Bentler & Bonett's (1980) NFI                             0.8321
James, Mulaik, & Brett (1982) Parsimonious NFI            0.7095
Z-Test of Wilson & Hilferty (1931)                        4.5490
Bollen (1986) Normed Index Rho1                           0.8031
Bollen (1988) Non-normed Index Delta2                     0.9303
Hoelter's (1983) Critical N                                   94
```

Once again, the overall goodness of fit indices for the model are acceptable, with values on the NNFI and CFI in excess of 0.90.

Output 29 gives the distribution of normalized residuals for the second modification. The shape is still asymmetrical.

Output 29 Distribution of normalized residuals: modification 2

```
                  Distribution of Normalized Residuals

                     Each * Represents 2 Residuals

----------Range---------     Freq    Percent

  -1.50000      -1.25000        2       0.95    *
  -1.25000      -1.00000        3       1.43    *
  -1.00000      -0.75000       12       5.71    ******
  -0.75000      -0.50000       16       7.62    ********
```

```
-0.50000      -0.25000      25      11.90    ************
-0.25000             0      52      24.76    *************************
       0       0.25000      49      23.33    ***********************
 0.25000       0.50000      22      10.48    ***********
 0.50000       0.75000      15       7.14    *******
 0.75000       1.00000       6       2.86    ***
 1.00000       1.25000       3       1.43    *
 1.25000       1.50000       1       0.48
 1.50000       1.75000       1       0.48
 1.75000       2.00000       3       1.43    *
```

The following output indicates that the factor loadings for F5 and F9 are non significant.

Output 30 Non-standardized factor loadings: modification 2

```
F9         =   0.8081*F4       +  0.1535*F5       +  1.0000 D9
Std Err        0.1587 PF9F4       0.1304 PF9F5
t Value        5.0918             1.1768
```

The Wald Test indicates that the model chi-square will improve if the causal paths from F5 on F9 were removed.

Output 31 Wald test results: modification 2

```
                    Stepwise Multivariate Wald Test

             ------Cumulative Statistics-----    --Univariate Increment--
Parameter    Chi-Square      DF    Pr > ChiSq    Chi-Square    Pr > ChiSq

VARE14          0.00450       1        0.9465       0.00450        0.9465
PF9F5           1.38933       2        0.4992       1.38483        0.2393
```

Modification 3:

The factor loading of F5 on F9 was non significant and the Wald Test indicated that, if the causal path were removed, the model chi-square would improve. Therefore, the causal relationship between F5 and F9 is removed in modification 3.

The goodness of fit indices are given below:

Output 32 Goodness of fit indices: modification 3

```
                       The CALIS Procedure
 Covariance Structure Analysis: Maximum Likelihood Estimation

 Fit Function                                              2.1040
 Goodness of Fit Index (GFI)                               0.8414
```

GFI Adjusted for Degrees of Freedom (AGFI)	0.7957
Root Mean Square Residual (RMR)	0.0586
Parsimonious GFI (Mulaik, 1989)	0.7219
Chi-Square	258.7883
Chi-Square DF	163
Pr > Chi-Square	<.0001
Independence Model Chi-Square	1533.7
Independence Model Chi-Square DF	190
RMSEA Estimate	0.0691
RMSEA 90% Lower Confidence Limit	0.0528
RMSEA 90% Upper Confidence Limit	0.0846
ECVI Estimate	3.0255
ECVI 90% Lower Confidence Limit	2.6927
ECVI 90% Upper Confidence Limit	3.4378
Probability of Close Fit	0.0286
Bentler's Comparative Fit Index	0.9287
Normal Theory Reweighted LS Chi-Square	231.7769
Akaike's Information Criterion	-67.2117
Bozdogan's (1987) CAIC	-689.9176
Schwarz's Bayesian Criterion	-526.9176
McDonald's (1989) Centrality	0.6796
Bentler & Bonett's (1980) Non-normed Index	0.9169
Bentler & Bonett's (1980) NFI	0.8313
James, Mulaik, & Brett (1982) Parsimonious NFI	0.7131
Z-Test of Wilson & Hilferty (1931)	4.5488
Bollen (1986) Normed Index Rho1	0.8033
Bollen (1988) Non-normed Index Delta2	0.9301
Hoelter's (1983) Critical N	94

The overall goodness of fit indices for the model are acceptable, with values on the NNFI and CFI in excess of 0.90.

Output 33 gives the distribution of normalized residuals for the second modification. The shape is still asymmetrical.

Output 33 Distribution of normalized residuals: modification 3

Each * Represents 2 Residuals

----------Range---------		Freq	Percent	
-1.50000	-1.25000	1	0.48	
-1.25000	-1.00000	3	1.43	*
-1.00000	-0.75000	11	5.24	*****
-0.75000	-0.50000	19	9.05	*********
-0.50000	-0.25000	23	10.95	***********
-0.25000	0	50	23.81	*************************
0	0.25000	50	23.81	*************************
0.25000	0.50000	24	11.43	************
0.50000	0.75000	15	7.14	*******
0.75000	1.00000	5	2.38	**
1.00000	1.25000	4	1.90	**
1.25000	1.50000	1	0.48	
1.50000	1.75000	1	0.48	

```
1.75000     2.00000     2     0.95     *
2.00000     2.25000     1     0.48
```

The following output indicates that the factor loading for F4 on F9 is significant.

Output 34 Non-standardized factor loadings: modification 3

```
F9        =   0.9392*F4      +  1.0000 D9
Std Err       0.1217 PF9F4
t Value       7.7157
```

The Wald Test indicates that the model chi-square will improve if VARE14 were removed. The value is insignificant and this suggestion is therefore ignored.

Output 35 Wald test results: modification 3

```
                     Stepwise Multivariate Wald Test

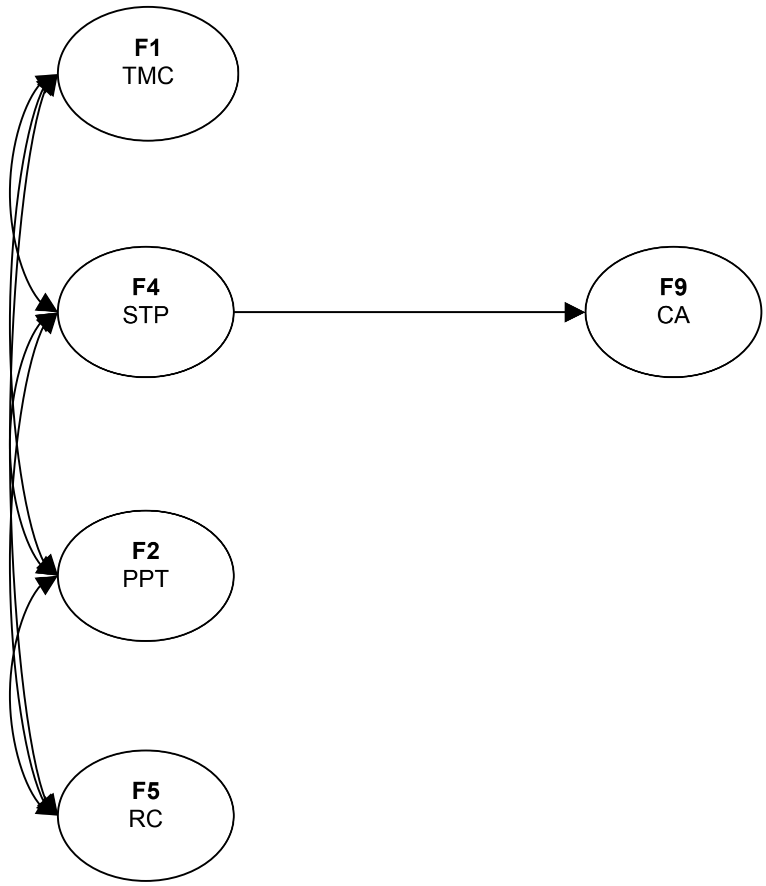
               ------Cumulative Statistics-----    --Univariate Increment--
Parameter    Chi-Square      DF    Pr > ChiSq    Chi-Square    Pr > ChiSq

VARE14          0.00449       1        0.9466       0.00449        0.9466
```

Figure 24 is a schematic representation of the third modification model. The diagram indicates that only factor F4 (Stakeholder Relationships) exerts a causal relationship on F9 (Competitive Advantage) and all the other factors covary.

Output 36 provides the correlations among the exogenous variables for the third revised model. The data indicates a very high correlation between factors F1 and F4: CF1F4 = 0.87661; factor F1 being Top Management Commitment and factor F4 being Stakeholder Relationships. One of the conditions for path analysis given by Hatcher (1994) is that the variables in the model should be **free of multicollinearity**. Variables F1 and F4 contravene this criterion because their covariance is greater than 0.80.

Figure 24 Revised theoretical model: modification 3



Output 36 Correlations among exogenous variables: modification 3

Var1	Var2	Parameter	Estimate
F1	F2	CF1F2	0.46504
F1	F4	CF1F4	0.87661
F2	F4	CF2F4	0.56611
F1	F5	CF1F5	0.66316
F2	F5	CF2F5	0.37109
F4	F5	CF4F5	0.78273

In an attempt to satisfy the multicollinearity criterion, the researcher modified the model to test whether factor F1 exerts a causal effect on factor F4.

Modification 4:

A causal path from factor F1 on factor F4 is inserted. The goodness of fit indices are given below:

Output 37 Goodness of fit indices: modification 4

```
                       The CALIS Procedure
Covariance Structure Analysis: Maximum Likelihood Estimation

Fit Function                                           2.2925
Goodness of Fit Index (GFI)                            0.8292
GFI Adjusted for Degrees of Freedom (AGFI)             0.7826
Root Mean Square Residual (RMR)                        0.0692
Parsimonious GFI (Mulaik, 1989)                        0.7201
Chi-Square                                           281.9830
Chi-Square DF                                             165
Pr > Chi-Square                                        <.0001
Independence Model Chi-Square                          1533.7
Independence Model Chi-Square DF                          190
RMSEA Estimate                                         0.0759
RMSEA 90% Lower Confidence Limit                       0.0606
RMSEA 90% Upper Confidence Limit                       0.0908
ECVI Estimate                                          3.1749
ECVI 90% Lower Confidence Limit                        2.8170
ECVI 90% Upper Confidence Limit                        3.6115
Probability of Close Fit                               0.0039
Bentler's Comparative Fit Index                        0.9129
Normal Theory Reweighted LS Chi-Square               253.4283
Akaike's Information Criterion                       -48.0170
Bozdogan's (1987) CAIC                              -678.3635
Schwarz's Bayesian Criterion                        -513.3635
McDonald's (1989) Centrality                           0.6239
Bentler & Bonett's (1980) Non-normed Index             0.8998
Bentler & Bonett's (1980) NFI                          0.8161
James, Mulaik, & Brett (1982) Parsimonious NFI         0.7088
Z-Test of Wilson & Hilferty (1931)                     5.3661
Bollen (1986) Normed Index Rho1                        0.7883
Bollen (1988) Non-normed Index Delta2                  0.9145
Hoelter's (1983) Critical N                                87
```

CFI is in excess of 0.90 but NNFI is slightly lower at 0.8998. The following output indicates that the factor loading of F1 on F4 is significant.

Output 38 Non-standardized factor loadings: modification 4

```
F9      =   0.9132*F4      +  1.0000 D9
Std Err     0.1209 PF9F4
t Value     7.5536
F4      =   1.3041*F1      +  1.0000 D4
Std Err     0.1926 PF4F1
t Value     6.7694
```

Output 39 gives the distribution of normalized residuals for the fourth modification. The shape is still asymmetrical.

Output 39 Distribution of normalized residuals: modification 4

```
                  Distribution of Normalized Residuals

                          Each * Represents 2 Residuals

----------Range---------    Freq    Percent

  -1.50000      -1.25000       1       0.48
  -1.25000      -1.00000       6       2.86    ***
  -1.00000      -0.75000       5       2.38    **
  -0.75000      -0.50000      20       9.52    **********
  -0.50000      -0.25000      31      14.76    ***************
  -0.25000             0      44      20.95    **********************
         0       0.25000      43      20.48    *********************
   0.25000       0.50000      16       7.62    ********
   0.50000       0.75000      17       8.10    ********
   0.75000       1.00000       9       4.29    ****
   1.00000       1.25000       6       2.86    ***
   1.25000       1.50000       7       3.33    ***
   1.50000       1.75000       0       0.00
   1.75000       2.00000       4       1.90    **
   2.00000       2.25000       0       0.00
   2.25000       2.50000       0       0.00
   2.50000       2.75000       0       0.00
   2.75000       3.00000       0       0.00
   3.00000       3.25000       1       0.48
```

The Wald Test indicates that the model chi-square will improve if VARE14 were removed. The value is insignificant and this suggestion is therefore ignored.

Output 40 Wald test results: modification 4

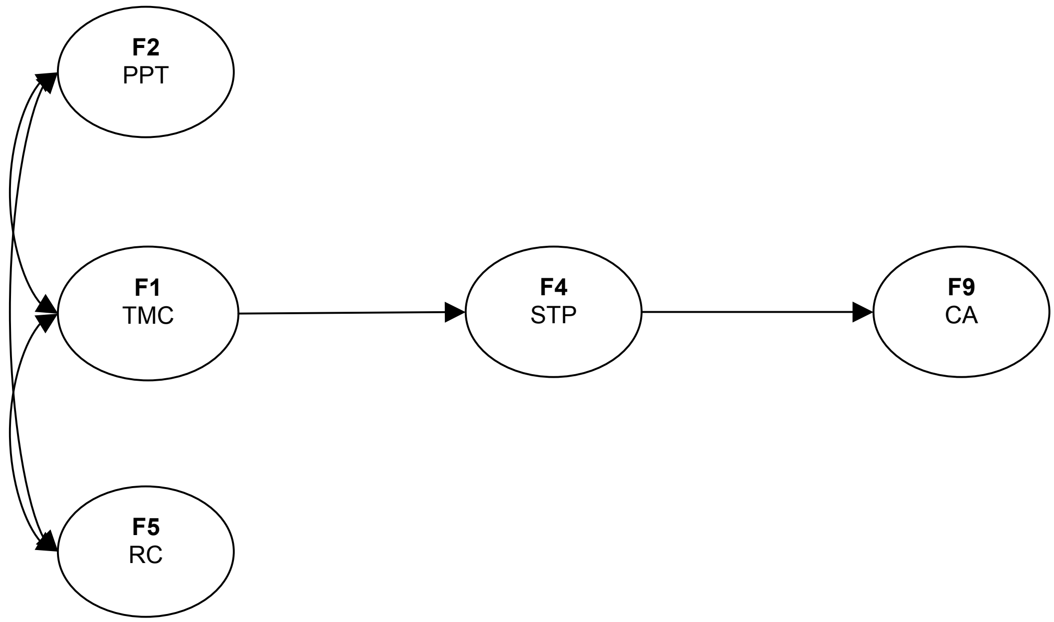
```
                       Stepwise Multivariate Wald Test

             ------Cumulative Statistics-----    --Univariate Increment--
Parameter    Chi-Square      DF    Pr > ChiSq    Chi-Square    Pr > ChiSq

VARE14          0.00449       1        0.9466       0.00449        0.9466
```

The fourth revised model is given in Figure 25. The SAS System PROC CALIS program is attached as Appendix K.

Figure 25 Revised theoretical model: modification 4



5.6.4 Selecting the causal model of best fit

The parsimony indices for the four modified models were calculated to decide which causal model provides the best fit for the data. The indices are explained below (Hatcher 1994) and their equations are given in Appendix L.

The following four indices measure the fit of the combined model which includes both the measurement model and structural model:

- The model chi-square test;
- The normed-fit index (NFI);
- The non-normed fit index (NNFI);
- The comparative fit index (CFI).

The parsimony ratio (PR) is a measure of the “simplicity” of the model fit for the combined model. The parsimonious normed-fit index (PNFI) measures both the fit and parsimony of the combined model.

The relative normed-fit index or RNFI measures the fit of only the structural portion of the model. The relative parsimony ratio measures the parsimony of the structural model and the relative parsimonious fit index (RPFI) measures both the fit and parsimony of the structural model.

Table 14 gives the goodness of Fit and Parsimony Indices for the Environmental Management and Profitability Model.

Table 14 Goodness of fit and parsimony indices for the Environmental Management and Profitability model

	Combined Model	**Structural Model**

Model	Chi-square	df	NFI	NNFI	CFI	PR	PNFI	RNFI	RPR	RPFI
M_o	1533.7	190	----	----	----	----	----	----	----	----
M_u	591.78	170	0.614	0.649	0.686	0.895	0.549	0.000	1.0	0.00
M_t	256.38	160	0.8328	0.9148	0.9283	0.842	0.701	1.000	0.0	0.00
M_{r1}	256.49	161	0.8328	0.9161	0.9289	0.847	0.705	1.00	0.1	0.1
M_{r2}	257.54	162	0.8321	0.9166	0.9289	0.853	0.709	1.00	0.2	0.2
M_{r3}	258.79	163	0.8313	0.9169	0.9287	0.858	0.713	1.00	0.3	0.3
M_{r4}	281.98	165	0.8161	0.8998	0.9129	0.87	0.709	0.9376	0.5	0.47
M_m	256.38	160	0.8328	0.9148	0.9283	0.842	0.701	1.000	0.0	0.00

When having to choose between models that display an acceptable and similar fit, the more desirable model will be the one with the higher parsimony ratio (Hatcher 1994). From the table, the model with the highest parsimony ratio is the fourth modification M_{r4} where PR = 0.87. The parsimony of a model reflects its "simplicity".

The parsimonious normed-fit index (PNFI) is an index that reflects both the fit and the parsimony of the model simultaneously (Hatcher 1994). A higher reflects a better model. The table indicates that the third model revision provides the highest PNFI at 0.713. The PNFI for the fourth revision model is only slightly lower at 0.709.
The relative normed-fit index (RNFI) reflects the fit in just the structural portion of the model and is not influenced by the fit of the measurement model (Hatcher 1994). The higher values indicate that the hypothesized causal relations between the structural variables provide a good fit of the data. From the table it is clear the third

model revision has a higher value for RNFI (at 1.00) than the fourth model revision (RNFI = 0.9376).

The relative parsimony ratio (RPR) measures the parsimony of the structural portion of the model (Hatcher 1994). From the table, it is clear that the relative parsimony for the fourth model revision is higher at RPR=0.5 than for the third model revision.

The relative parsimonious-fit index (RPFI) is a single index that reflects both the fit and the parsimony in just the structural portion of the model simultaneously (Hatcher 1994). From the table it can be seen that the RPFI for model revision four is the highest at RPFI = 0.47.

The above indices show that:

- The model with the highest parsimony ratio (PR) is the fourth modification M_{r4} where PR = 0.87.
- The third model revision has a slightly higher PNFI of 0.713 compared to the PNFI for the fourth revision model of 0.709.
- The third model revision has a higher value for RNFI of 1.00 than the fourth model revision RNFI = 0.9376.
- The fourth model revision has a higher RPR value of 0.5 than for the third model revision of RPF = 0.3.
- The RPFI for the fourth model revision is the highest at RPFI = 0.47. The RPFI for model revision three is 0.3

The fourth model revision has the highest parsimony ratio (an index reflecting the model's simplicity) and the highest relative parsimonious fit index (and index reflecting both the fit and the parsimony in just the structural portion of the model).

As a final test, a chi-square difference test was used to compare the fit of M_{r4} with that of M_{r3}. In this comparison, the difference in chi-square values is 281.98 – 258.79 = 23.19 with 2 degrees of freedom. The critical value of chi-square for 2 degrees of freedom at $p < 0.001$ is 13.816 (Hatcher, 1994 p.570). The chi-square difference of 23.19 is therefore greater than 13.816 indicating that the difference test is significant at $p < 0.001$. The test shows, therefore, that the revised model 4 provides a model fit that is superior to that of the revised model 3.

Combined, these indices show that revised model 4 is a better model fit of the data than revised model 3.

5.6.5 Best theoretical model fit: modification 4

The results of revised model 4 are summarized again:

- The model chi-square is 281.98 with 165 degrees of freedom and Pr > chi-square at <0.0001.
- The chi-square to *df* ratio is 1.7.
- The CFI is 0.9121 and the NNFI is 0.8998 (which is only slightly lower than the recommended value of 0.9).
- The *t* values for all factor loadings are statistically significant.
- All standardized factor loadings are non trivial in absolute value – excluding V14.
- R^2 values for the Competitive Advantage factor (F9) and the Stakeholder Partnerships (F4) factor are large at 0.7633 and 0.8240 respectively.
- The distribution of normalized residuals is centered around zero, but still slightly asymmetrical.
- One standardized residual had an absolute value of 3.0.
- Revised model 4 indicates a more parsimonious fit in the measurement part of the model than revised model 3.

- Although revised model 4 displays a slightly lower fit in the structural portion of the model than revised model 3 (as seen from the values of RNFI), the higher values of RPR and RPFI indicate a more parsimonious fit for revision model 4.
- The convergence criterion is satisfied.

Output 41 Standardized factor loadings: modification 4

```
              Manifest Variable Equations with Standardized Estimates


       V1      =   0.6264 F1     +  0.7795 E1
       V4      =   0.7962*F1     +  0.6050 E4
                          LV4F1
       V10     =   0.7007*F1     +  0.7135 E10
                          LV10F1
       V14     =   0.9979 F2     +  0.0653 E14
       V21     =   0.7104*F1     +  0.7038 E21
                          LV21F1
       V24     =   0.6536*F1     +  0.7568 E24
                          LV24F1
       V27     =   0.7792 F4     +  0.6268 E27
       V30     =   0.8466*F4     +  0.5322 E30
                          LV30F4
       V31     =   0.6018*F4     +  0.7987 E31
                          LV31F4
       V33     =   0.7740 F5     +  0.6331 E33
       V34     =   0.8160*F5     +  0.5781 E34
                          LV34F5
       V39     =   0.8394*F1     +  0.5435 E39
                          LV39F1
       V40     =   0.7471*F1     +  0.6647 E40
                          LV40F1
       V42     =   0.7363 F9     +  0.6767 E42
       V43     =   0.7461*F5     +  0.6658 E43
                          LV43F5
       V52     =   0.6836*F9     +  0.7299 E52
                          LV52F9
       V58     =   0.6284*F9     +  0.7779 E58
                          LV58F9
       V59     =   0.6605*F9     +  0.7508 E59
                          LV59F9
       V62     =   0.8357*F4     +  0.5492 E62
                          LV62F4
       V64     =   0.7123*F9     +  0.7019 E64
                          LV64F9
```

Output 41 indicates that all standardized factor loadings are significant.

Output 42 R^2 values for manifest variables: modification 4

```
                       Squared Multiple Correlations

                                       Error         Total
```

	Variable	Variance	Variance	R-Square
1	V1	0.46005	0.75707	0.3923
2	V4	0.36141	0.98732	0.6339
3	V10	0.88639	1.74139	0.4910
4	V14	0.00498	1.16887	0.9957
5	V21	0.73208	1.47783	0.5046
6	V24	0.77170	1.34721	0.4272
7	V27	0.39666	1.00966	0.6071
8	V30	0.31366	1.10724	0.7167
9	V31	0.69501	1.08963	0.3622
10	V33	0.44637	1.11353	0.5991
11	V34	0.27573	0.82507	0.6658
12	V39	0.41606	1.40851	0.7046
13	V40	0.62761	1.42037	0.5581
14	V42	0.56570	1.23544	0.5421
15	V43	0.43391	0.97876	0.5567
16	V52	0.56061	1.05239	0.4673
17	V58	0.49035	0.81042	0.3949
18	V59	0.71151	1.26218	0.4363
19	V62	0.28619	0.94903	0.6984
20	V64	0.36204	0.73484	0.5073
21	F9	0.15856	0.66975	0.7633
22	F4	0.10788	0.61301	0.8240

Output 43 Rank order of top 10 normalized residuals: modification 4

Row	Column	Residual
V43	V42	3.01126
V33	V30	1.99495
V52	V33	1.96540
V42	V33	1.82772
V40	V31	1.78382
V59	V33	1.49461
V58	V21	1.46478
V52	V14	1.44665
V52	V43	1.29078
V52	V34	1.28034

Output 44 Optimization results: modification 4

```
Iterations                              39  Function Calls
64
Gradient Calls                          44  Active Constraints
0
Objective Function            2.2925447224  Max Abs Gradient Element
0.0000712448
Slope of Search Direction     -1.117462E-8
```

GCONV convergence criterion satisfied.

6. DISCUSSION OF RESULTS

6.1 Overview of Data Analysis

The data collected in the study was analysed using the SAS system's PROC CALIS procedure and the original model that was tested was a covariance structure model with nine latent constructs and sixty-four indicator variables. Standard deviations and inter correlations for the study's 64 indicator variables are given in Appendix G.

The data analysis followed a two-step procedure: in the first step, confirmatory factor analysis was used to develop a measurement model that demonstrated acceptable fit to the raw data. The purpose of the measurement model is to determine if the indicator variables really are measuring the latent constructs. As such, the measurement model does not specify any causal relationships between the latent constructs – each latent construct is allowed to correlate freely with every other latent construct (Hatcher 1994).

In the second step, the measurement model was modified until it represented the causal model of interest. This analysis introduced causal paths to the measurement model and is known as path analysis with latent variables (Hatcher 1994). The analysis also tested the research hypotheses of the study.

6.2 The Measurement Model

A measurement model describes the relationship between the latent factors and the manifest indicator variables that measure the latent factors. The Environmental Management and Profitability model of this study consisted of nine constructs: Environmental Management described by six factors, namely Top Management Commitment, Risk Management, Stakeholder Partnerships, Employee Relations, Product and Process Technology and Resources Conservation. Profitability was described by three factors, namely Return on Investment, Intellectual Capital and Competitive Advantage.

6.2.1 The initial measurement model

This study follows the convention by Bentler (1989; cited by Hatcher 1994) of identifying latent factors with the letter F and manifest variables with the letter V. The initial measurement model is given in Figure 21. The figure indicates that latent factor Top Management Commitment (F1) is measured by the indicator variables V1 to V12 and the latent factor Product & Process Technology (F2) is measured by the indicator variables V13 to V19 (for example).

The initial measurement model does not contain causal relationships between latent variables. The model only estimates the covariance between each latent variable with every other latent variable. In Figure 21, covariance is indicated by a curved, two-headed arrow connecting each F variable to every other F variable. The measurement model is therefore equivalent to a confirmatory factor analysis model which contains only covariance between latent factors.

The initial measurement model was estimated using the maximum likelihood method and the chi-square value for the model was statistically significant, χ^2 (1916, N = 125) = 3644, p < 0.0001. The chi-square test may be used to test the null hypothesis that the model fits the data. The test is very sensitive to sample size and deviations from multivariate normality will often result in rejection of a good-fit model (Hatcher 1994). The chi-square test is therefore only used as a goodness of fit index and smaller chi-square values (relative to the degrees of freedom) indicate a better model fit. A rule of thumb used for the criterion is that the chi-square to *df* ratio should be less than 2 for a model to fit the data. This ratio was equal to 1.90 for the initial measurement model.

The other goodness of fit indices indicated that the initial measurement model did not provide a good fit of the data. The GFI (goodness-of-fit index) was only 0.53, Bentler's comparative-fit index (CFI) was 0.67 and Bentler and Bonett's non-normed fit index (NNFI) was 0.66.

Output 5 indicates that the distribution of normalized residuals for the initial measurement model is centered on zero and is relatively symmetrical. The normal distribution of the data is an indication that the sample data is representative of the population data. The ten highest normalized residuals, however, all had absolute values greater than 2 and therefore the model does not provide a good fit of the raw data (see Output 6)

Inspection of the factor loadings indicated that the factor loadings of V45 and V50 were non significant for both the raw data and standardized data. In addition, the Wald test recommended that the model chi-square would improve if the path between the variable indicator V45 and Factor 7 and the path between variable indicator V50 and F7 were removed. The first modification of the measurement model therefore removed V45 and V50 from the data set.

Twelve modifications were required to achieve an acceptable model fit. In iteration 12 the goodness of fit indices for the model were acceptable and the distribution of normalized residuals was centered on zero and symmetrical about the centre. Furthermore, no normalized residuals were greater than an absolute value of 2 and no non-significant factor loadings were present. A further criterion for model fit, however, is the test of discriminant validity which indicates whether the factors are measuring different concepts (Hatcher 1994). This test indicated that little discriminant validity existed in the model.

Another modification was performed. Iteration 13 once again produced an acceptable model fit, but the discriminant validity test indicated that factors F1 and F6 showed no discriminant validity. The variables for F6 (V39 and V40) were then loaded on F1.

6.2.2 The final revised measurement model

Finally, iteration 14 provided an acceptable model fit with χ^2 (160, $\underline{N} = 125$) = 256, $\underline{p} < 0.0001$) and a chi-square to *df* ratio of 1.6. GFI = 0.84, CFI = 0.9283 and NNI = 0.9148.

All absolute values of the normalized residuals were less than two and the distribution of normalized residuals was centered on zero but slightly asymmetrical. The non standardized factor loadings indicated that V14 displays a zero standard error – this creates an estimation problem and shows that V14 is linearly dependent on other parameters in the model. V14 also measures factor F2 completely (indicated by the standardized factor loading LV14F2 = 1.0050 in Output 15) and as such, the model should be programmed as a non-standard model. Attempts to model a non-standard model did not improve the model fit and the researcher *proceeded data analysis with the current standard model*. V14 is possibly the reason for the asymmetrical shape of the distribution.

Standardized factor loadings for the indicator variables are given in Table 12. The SAS System's PROC CALIS procedure provides standard errors for these coefficients which allow large-sample *t* tests of the null hypothesis that the coefficients are equal to zero in the population. The *t* scores obtained for the coefficients range from 6.94 to 16.38, indicating that all factor loadings are significant at $\underline{p} < 0.001$. This finding provides evidence supporting the convergent validity of the indicators. Convergent validity is demonstrated when different instruments are used to measure the same construct and scores from these different instruments are strongly correlated (Hatcher 1994).

Table 12 also gives the reliabilities of the indicators (equal to the square of the factor loadings) and the composite reliability for each construct. Composite reliability is a measure of internal consistency comparable to Cronbach's coefficient alpha. All five constructs display very high composite reliabilities (greater than 0.80). Composite reliabilities are acceptable when they exceed the value of 0.70.

The final column in Table 12 gives the variance extracted estimate for each construct. This is a measure of the amount of variance captured by the construct relative to the amount of variance due to random measurement error. Four of the five constructs demonstrated variance extracted estimates in excess of 0.50 which is the recommended level. The variance extracted estimate for Competitive Advantage was 0.47 which indicates that 53% of the variance in the construct is due to measurement error. There may be two reasons that account for this: firstly, the sample size for this study is small (N = 125), although reliability of constructs was high (indicated in Table 7) and the distribution of normalized residuals was centered on zero and symmetrical. Secondly, the value for significant indicator variables used in this study was 0.60 which may have been too high - this may have caused significant indicator variables to be eliminated from the factor Competitive Advantage giving rise to measurement error.

Finally, Table 13 gives data that demonstrates the discriminant validity of iteration 14. Combined, these findings support the reliability and validity of the constructs and their indicators. The revised model of iteration 14 was therefore accepted as the study's final measurement model M_m (given in Figure 22).

6.3 The Structural Model

6.3.1 The initial theoretical model

The initial theoretical model is given in Figure 23. The model shows that causal relationships have been introduced to the model: the factors Top Management Commitment, Stakeholder Partnerships, Product & Process Technology and Resource Conservation have a unidirectional, positive causal effect on the factor Competitive Advantage. The analysis of this model is known as path analysis with latent variables.

Goodness of fit indices for the model appear in Table 14 in the row named M_t for Theoretical Model. Values on the NNFI and CFI exceeded 0.90. However, non-significant factor loadings and non-significant *t*-values were present for all causal relationships except the causal relationship between factors 4 and 9 where PF9F4 = 0.8136 and the *t*-value = 2.57. This provided evidence that the suggested causal model did not provide a good fit for the data.

Four modifications were performed to arrive at a better model fit. In modification 1, the causal path from F1 to F9 was removed because the factor loading of F1 on F9 was negative and non significant. The overall goodness of fit indices for modification 1 were acceptable with values on the NNFI and CFI in excess of 0.90. But the factor loadings of F2 and F5 on F9 were found to be non significant and the Wald Test indicated that the model chi-square would improve if the causal paths from F2 and F5 on F9 were removed.

In modification2, therefore, the causal path from F2 to F9 was removed. Once again, the overall goodness of fit indices for the model were acceptable, with values on the NNFI and CFI in excess of 0.90. Again the factor loading of F5 on F9 were found non significant and the Wald Test indicated that the model chi-square would improve if the causal path from F5 to F9 were removed.

The causal relationship between F5 and F9 was removed in modification 3. The overall goodness of fit indices for the model were acceptable, with values on the NNFI and CFI in excess of 0.90. The Wald Test indicated that the model chi-square will improve if VARE14 were removed. The value was insignificant and this suggestion was therefore ignored. The factor loading of F4 on F9 was found to be highly significant.

The correlations among the exogenous variables for the third revised model indicated that a very high correlation existed between factors F1 and F4: CF1F4 = 0.87661. This contravenes the requirement of path analysis that multicollinearity should be absent from the model. The researcher modified the model to test whether factor F1 exerts a causal influence on factor F4.

In modification 4 a causal path was inserted from factor F1 to factor F4. The goodness of fit indices were as follows: CFI =0.9129 and NNFI = 0.8998. The following output indicates that the factor loading of F1 on F4 is significant.

Output 45 Non-standardized factor loadings: modification 4

```
F9        =   0.9132*F4       +  1.0000 D9
Std Err       0.1209 PF9F4
t Value       7.5536
F4        =   1.3041*F1       +  1.0000 D4
Std Err       0.1926 PF4F1
t Value       6.7694
```

The Wald Test indicated that the model chi-square will improve if VARE14 were removed. The value is insignificant and the suggestion was therefore ignored. The distribution of normalized residuals was centered on zero but still slightly asymmetrical. One standardized residual had an absolute value greater than 2.

6.3.2 The final revised causal model

Table 14 gives the indices that reflect the parsimony of the models that were tested. The parsimony ratio (PR) reflects the parsimony of the overall model, with higher values reflecting greater parsimony. The parsimonious normed-fit index (PNFI) is obtained by multiplying the parsimony ratio by the normed-fit index, resulting in a single index that reflects the parsimony and the fit of the overall model. The indices show that modification 4 is the model with the highest parsimony ratio of PR = 0.87. The third model revision, however, has a slightly higher PNFI of 0.713 compared to the PNFI for the fourth revision model of 0.709.

Table 14 also gives the indices that represent the fit and parsimony in just the structural portion of the model – in other words, the part of the model that describes the causal relationships between factors. The relative-normed fit index (RNFI) shows the fit achieved in just the structural portion of the model, independent of the fit of the measurement model. The relative parsimony ratio (RPR) shows the parsimony of only the structural part of the model and the relative parsimony ratio (RPFI) is obtained by multiplying the RNFI by the RPR. The RPFI shows how well the model explains all possible relations among the F variables (Hatcher 1994).

The RNFI for the third model revision was higher at 1.00 than the RNFI for the fourth model revision at RNFI = 0.9376. This index therefore shows that the fit for the structural part of model three was better than the fit of the structural part of model four.

The fourth model revision, however, had a higher RPR value of 0.5 than for the third model revision of RPR = 0.3. Finally, the RPFI for the fourth model revision was the highest at RPFI = 0.47. The RPFI for model revision three was 0.3. Since the RPFI indicates how well the model explains all possible relations among the F variables, incorporating both fit and parsimony in the structural part of the model, revision model 4 was selected as the final causal model of the study.

As a final test, a chi-square difference test was used to compare the fit of M_{r4} with that of M_m. In this comparison, the difference in chi-square values is 281.98 – 256.38 = 25.6 with 5 degrees of freedom. The critical value of chi-square for 5 degrees of freedom at $p < 0.001$ is 20.515 (Hatcher, 1994 p.570). The chi-square difference of 25.6 is therefore greater than 20.515 indicating that the difference test is significant at $p < 0.001$. The test shows that the revised model 4 provides a model fit that is significantly superior to that of the measurement model.

Combined, these findings provide support for accepting revised model 4 as the final model of the study. Table 15 and Figure 26 display the standardized path coefficients for the final model of the Environmental Management and Profitability study. It can be seen that all the coefficients are significant and in the predicted direction. R^2 values show that Stakeholder Partnerships accounted for 76% of the variance in Competitive Advantage, whilst Top Management Commitment accounted for 82% of the variance in Stakeholder Partnerships.

The model states simply that Top Management Commitment exerts a strong positive causal effect on Stakeholder Partnerships and in turn Stakeholder Partnerships exerts a strong positive causal effect on Competitive Advantage when a firm practices environmental management. Stakeholder Partnerships is known as a mediator variable: a variable that conveys the effect of the antecedent variable (Top Management Commitment) onto a consequent variable (Competitive Advantage).

Also, Product & Process Technology and Resource Conservation covary with Top Management Commitment but do not exert a causal effect on Competitive Advantage.

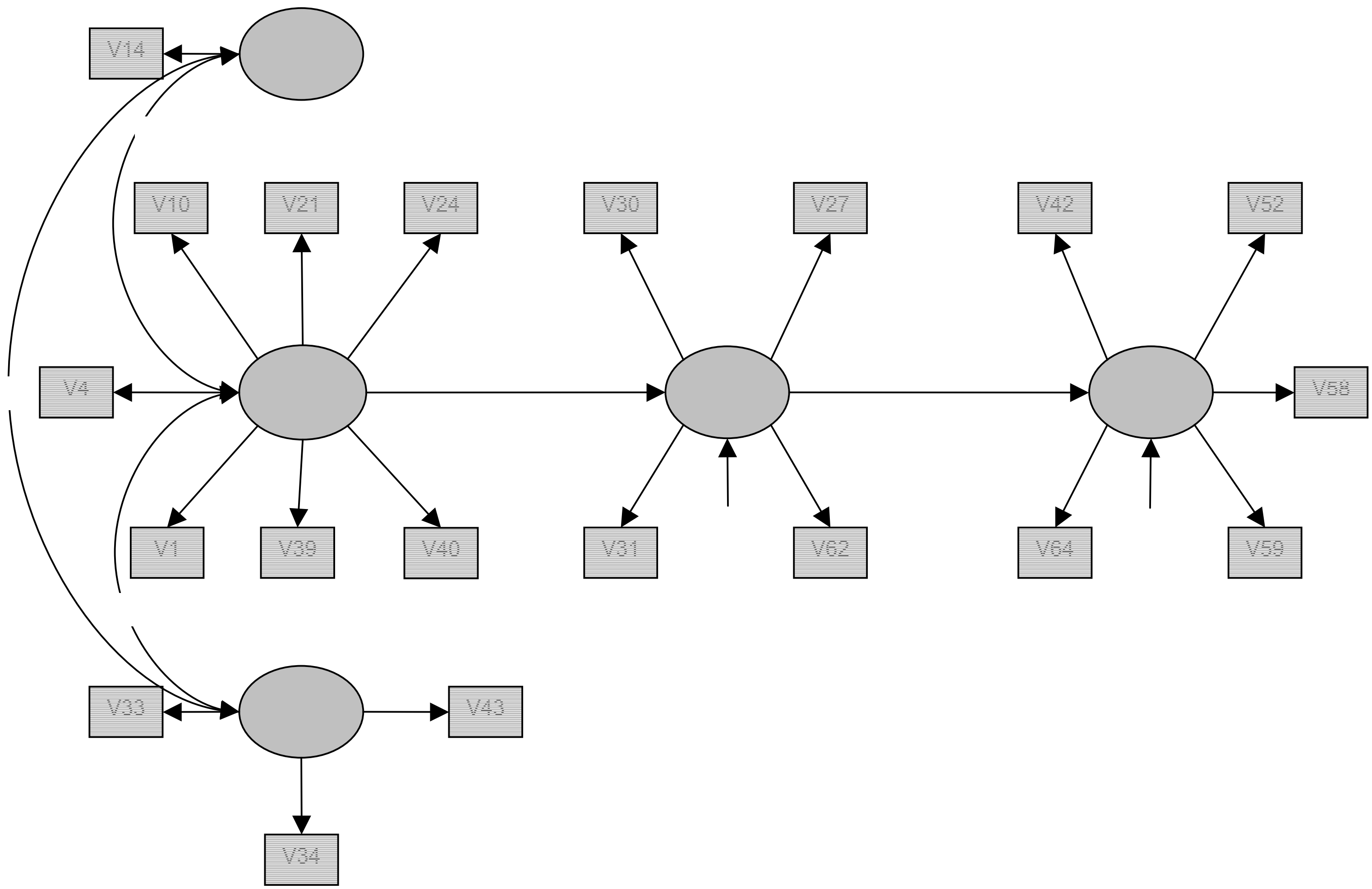
Table 15 Standardized path coefficients for Environmental Management and Profitability model

Competitive Advantage (F9)	**Top Management Commitment (F1)**	**Product and Process Technology (F2)**	**Stakeholder Partnerships (F4)**	**Resource Conservation (F5)**
Theoretical Model	PF9F1 = -0.1108 t = -0.3483	PF9F2 = 0.062 t = 0.9036	PF9F4 = 0.8136 t = 2.5716	PF9F5 = 0.1736 t = 1.2427
Revised Model 1		PF9F2 = 0.0677 t = 0.0462	PF9F4 = 0.7240 t = 0.5570	PF9F5 = 0.1869 t = 0.7309
Revised Model 2			PF9F4 = 0.8081 t = 5.0918	PF9F5 = 0.1535 t = 1.1768

Revised Model 3			PF9F4 = 0.9392 t = 7.7157	
Revised Model 4	PF9F4 = 0.8736 t = 7.55		PF4F1 = 0.9077 t = 6.77	

Note: N = 125

Figure 26 Environmental Management and Profitability Model



7. CONCLUSIONS

7.1 Research Questions and Objectives

The first research question of this study read as follows:

> **Does environmental management increase a firm's profitability in South African-based firms?**

The primary objective of the study was therefore to determine whether a South African-based firm's profitability increases when it practices environmental management.

A study conducted by Rawicz (1994) indicated that South African-based firms implement environmental management for the following reasons:

1. To comply with environmental legislation and regulations and to comply with waste and pollution minimization standards;
2. To satisfy growing public pressure and social demands;
3. To meet new market demands;
4. To minimize risk and liability exposure;
5. To meet the requirements of international trading partners.

Following, the secondary research question of this paper was:

> **What are the key factors that cause a South African-based firm to implement environmental management strategies?**

It follows that the secondary research objective is to determine these factors.

After delineation of the concepts Environmental Management and Profitability from the literature study, the concepts were found to be defined by the following factors:

Environmental Management was defined by six factors, namely: Top Management Commitment, Product & Process Technology, Risk Management, Stakeholder Partnerships, Employee Relations and Resource Conservation.

Profitability was defined by three factors, namely: Return on Investment, Intellectual Capital and Competitive Advantage.

The nine factors of the study were measured with a total of 64 indicator variables and complete research questionnaires were received from 125 respondents of the designations of director, top management and middle management of firms in ten different sectors of the South African economy.

The researcher proposed that environmental management has a positive causal effect on a firm's profitability – the proposed model is illustrated in Figure 8. Confirmatory factor analysis was conducted on the raw data using the SAS System's PROC CALIS procedure.

The analysis indicated that both the factors Risk Management and Employee Relations actually form part of the factor Top Management Commitment. As a result, the former two factors were dropped from the model as independent factors. Four factors remained to measure the latent factor Environmental Management: Top Management Commitment, Stakeholder Partnerships, Resource Conservation and Product & Process Technology. The factor Product & Process Technology was measured completely by only one variable, V14: Our firm designs new products to minimize the product's environmental impact.

The results also showed that Profitability is only measured by the factor Competitive Advantage and consequently the factors Return on Investment and Intellectual Capital were dropped from the model.

Path analysis with latent variables tested the proposed causal relationships between the latent factors. Path analysis demonstrated that Top Management Commitment exerts a strong positive causal effect on Stakeholder Partnerships and in turn Stakeholder Partnerships exerts a strong positive causal effect on Competitive Advantage when a firm practices environmental management. Stakeholder Partnerships thus acts as a mediator variable which conveys the effect of the antecedent variable (Top Management Commitment) onto a consequent variable (Competitive Advantage). Also, Product & Process Technology and Resource Conservation covary with Top Management Commitment but do not exert a causal effect on Competitive Advantage.

Top Management Commitment, Product & Process Technology and Resource Conservation all displayed a covariance of +0.3. The final model for the Environmental Management and Profitability study is given in Figure 26.

7.2 Research Hypotheses

Ten hypotheses were developed in the study to facilitate answering the research questions. The hypotheses are discussed below.

7.2.1 Environmental management

H1: Top Management Commitment is related to Environmental Management.
H3: Risk Management is related to Environmental Management.
H4: Stakeholder Partnerships is related to Environmental Management.
H6: Employee Relations is related to Environmental Management.

Figure 26 indicates that Top Management Commitment exerts a strong positive causal effect on Stakeholder Partnerships. This is evident from the path coefficient between the two factors which is highly significant at +0.8736. R^2 values show that Top Management Commitment accounted for 82% of the variance in Stakeholder Partnerships.

In the final model Top Management Commitment was measured by seven indicator variables:

V1: Top management drives and supports environmental initiatives within the firm.
V4: Top management budgets for the implementation of environmental projects.
V10: We have implemented (or are in the process of implementing) a formal environmental management system (for example, ISO 14001).
V21: We have external, independent audits conducted on our processes.
V24: Environmental regulation is a major concern for our firm.
V39: Key personnel are appointed for environmental issues.
V40: We provide environmental management training for our employees.

Top Management Commitment thus incorporates test items from the factor Risk Management (V21 and V24) and test items from the factor Employee Relations (V39 and V40). As such, the model indicates that the top management of a firm is responsible for driving, implement and supporting environmental initiatives in the firm, including environmental management systems such as ISO 14001.

Also, top management manages the environmental risk of the firm: defined as the consequence of non conformance with environmental regulation. It can therefore be concluded that environmental regulation and the need to minimize risk and liability exposure are two reasons for South African-based firms to implement environmental management.

The model indicates that **Top Management Commitment increases a firm's Competitive Advantage indirectly: Top Management Commitment first positively affects Stakeholder Partnerships which in turn positively affects Competitive Advantage.** Stakeholder Partnerships is measured by four indicator variables:

V27: Our firm promotes environmental partnerships with the community.
V30: We communicate our firm's environmental performance with stakeholders.

V31: We provide technical training for contractors with regard to our environmental requirements.

V62: We have developed strong relationships with stakeholders by communicating environmental performance data.

The first test item V27 indicates that promoting partnerships with the community is a determinant of competitive advantage. This is another reason for a firm to practise environmental management. Secondly, V30 and V62 indicate that communication of a firm's environmental performance positively affects stakeholder relationships. Stakeholders were defined as government, communities, suppliers and shareholders. It is interesting to note that contractors were included as stakeholders.

The path coefficient of Stakeholder Partnerships and Competitive Advantage was significant at +0.8736 and Stakeholder Partnerships accounted for 76% of the variance in Competitive Advantage. Therefore, **Stakeholder Partnerships has a direct and significantly positive causal effect on a firm's Competitive Advantage.**

> **A firm achieves competitive advantage when it promotes stakeholder partnerships and stakeholder partnerships are determined by top management.**

The research therefore accepts hypotheses H1 and H4.

H2: Product & Process Technology is related to Environmental Management.
H5: Resource Conservation is related to Environmental Management.

The construct Product & Process Technology is measured by only one indicator variable:

V14: Our firm designs new products to minimize the product's environmental impact.

The exclusion of the other (original) test items of the construct is very indicative of the level of environmental technical expertise contained in South African-based firms. To explain, the excluded test items are reproduced below:

V13: Our firm recycles the waste (or some thereof) resulting from the use of its products after consumption.

V15: We apply product life-cycle analysis in our firm.

V16: We modify our production system to reduce pollution.

V17: The firm treats its wastes (air emissions, effluents and solid waste) before discharge into the environment.

V18: We implement end-of-pipe technology to reduce pollution.

V19: We measure and monitor the quantity and quality of air emissions, effluents and waste generated by the process.

The exclusion of these items implies the following:

- South African-based firms do not recycle the waste of its products after consumer consumption.
- Product life-cycle analysis is not implemented in South African-based firms.
- Production systems are not modified to reduce pollution.
- Firms do not treat their waste before discharging it to the environment (this includes the lack of implementation of end-of-pipe technology to reduce pollution).
- Emissions, waste and effluent are not measured and monitored before discharge to the environment.

These findings support a study conducted by the Department of Trade and Industry in 2003 which profiled and benchmarked the South African environmental industry (The Need for a South African Environmental Goods and Services Industry – First Draft Discussion Document 2003). The study found that South Africa **lacks highly skilled professionals with the ability to redesign industrial processes in order to reduce**

waste and pollution and increase efficiency, thus incurring savings and improving bottom lines.

South African-based firms do, however, design new products to minimize the product's environmental impact. Product & Process Technology does not, however, have a causal effect on a firm's competitive advantage and only displays a covariance of +0.3 with Resource Conservation. Hypothesis H2 is therefore rejected.

The previous conclusion solicits the following inquiry: if processes and products are not designed to reduce pollution and waste is not monitored and minimized, what constitutes current environmental management practices in South African-based firms? The answer lies in the factor Resource Conservation. The final indicator variables of the factor are reproduced below:

V43 The firm reduces its use of resources, including water, electricity and land, thereby saving input costs.

V34 We implement programs to minimize the consumptions of resources on an on-going basis.

V33 The firm communicates resource consumption with stakeholders in financial terms.

The above test items show that firms in South Africa practise resource conservation. Originally, the construct measured two concepts: firstly, it measured the use of natural resources (water, energy and land) during the manufacture of a product. Secondly, it measured nature conservation or preservation, which includes wildlife protection, habitat protection and landscape protection.

The analysis shows that firms minimize and communicate their consumption of natural resources but they do not contribute to nature preservation (wildlife protection, habitat protection and landscape protection). Thus:

Current environmental management practice in South Africa constitutes the minimization of natural resource consumption.

This research indicates that Resource Conservation does not have a causal effect on a firm's competitive advantage but displays a covariance of +0.3 with Top Management Commitment and Process & Product Technology. Hypothesis H2 is therefore rejected.

7.2.2 Profitability

H7: Return on Investment is related to Profitability.
H8: Intellectual capital is related to Profitability.
H9: Competitive Advantage is related to Profitability.

In the final model, only the factor Competitive Advantage was retained as a measure of Profitability for a firm practising environmental management. The original definitions of Return on Investment and Intellectual Capital are reproduced below:

Return on Investment measured the potential revenue gained from investment in environmental initiatives as well as the potential cost savings or cost minimization achieved.

Intellectual Capital measured the potential innovation within the firm gained from compliance with environmental legislation, the patent and productivity benefits from process and product redesign and intellectual capital due to skills and knowledge of employees.

The exclusion of the former two factors indicate that South African-based firms do not measure the return on investment gained from investment in environmental initiatives and that firms do not contain intellectual capital gained from environmental innovation. South African-based firms cannot measure the return on investment gained from environmental initiatives if they only practice minimization of resource consumption (as a form of environmental management); they can, however, measure the cost savings achieved with resource conservation.

Also, if South African firms lack the technical skill to redesign industrial processes in order to reduce waste and pollution and increase efficiency they cannot contain the associated intellectual capital within the firm.

Hypotheses 7 and 8 are therefore rejected.

The study indicates that Competitive Advantage is a measure of Profitability for a firm practising environmental management. The final indicator variables are reproduced below:

V42 Environmental management leads to significant cost advantages for our firm.

V52 Environmental audits have identified opportunities for cost saving within the firm.

V58 Our firm has created barrier-to-market entry with our proactive relationships with policy makers.

V59 Compliance with legislation has allowed us to compete in international markets.

V64 Our firm has gained market share by reporting on environmental performance.

Test items V42 and V52 confirm that companies measure the cost savings achieved by practising environmental management. Also, firms in South Africa gain market share by communicating environmental performance and created barrier-to-market entry with proactive stakeholder relationships. This might explain why firms in South Africa design new products to minimize environmental impact (as measured by Product & Process Technology). Furthermore, compliance with environmental legislation allows firms to compete internationally.

The original definition of Competitive Advantage reads as follows: the potential competitive advantage gained by an increase in market share, entry into new markets, creation of barriers-to-market entry, employee commitment, reduction in environmental risk and long-term relationships with stakeholders – all gained from the practice of environmental management. The results confirm the definition above, but exclude employee commitment as a source of competitive advantage. This indicates that the practise of environmental management by South African-based firms does not promote the commitment of its employees to the company.

Hypothesis 9 is accepted.

7.3 Discussion

7.3.1 Answers to research questions and objectives

Does environmental management increase a firm's profitability in South African-based firms?

H10: Environmental Management increases a firm's Profitability.

Environmental Management is defined by Top Management Commitment, Stakeholder Relationships, Product & Process Technology and Resource Conservation. The practice of environmental management, however, is limited to natural resource conservation and the design of new products to minimize environmental impact. Top management determines and drives environmental initiatives and stakeholder relationships.

Profitability is defined by competitive advantage gained from the practice of environmental management. Currently, South African-based firms do not contain the intellectual capital necessary to redesign industrial processes in order to reduce waste and pollution and increase efficiency and South African-based firms do not measure the return on investment gained from environmental initiatives. South African firms do, however, measure the cost savings of resource conservation, create barrier-to-market entry with new products, comply with environmental legislation to compete internationally, promote stakeholder relationships and gain market share by communicating environmental performance.

As such, **environmental management does increase a firm's competitive advantage in South Africa**. Hypothesis 10 is therefore accepted and the primary research question is answered.

> **What are the key factors that cause a South African-based firm to implement environmental management strategies?**

The key factors that cause a South African-based firm to implement environmental management strategies are:

1. Conformance to environmental regulation for two reasons:
    (a) To minimize environmental risk and liability exposure.
    (b) To meet international standards and thereby allow international trading.

2. To promote environmental partnerships with stakeholders, including the community, government, policymakers, shareholders, suppliers, contractors.

3. To gain competitive advantage by gaining market share and creating barrier-to-market entries with new environmentally-designed products.

4. To minimize costs associated with resource consumption.

This research confirms Rawicz's findings (1994) but adds **competitive advantage** and **cost minimization** as two driving factors for the implementing environmental management in South African-based firms.

The secondary research question is therefore answered.

7.3.2 Implications for South African-based firms

This research is the first study in South Africa to provide empirical evidence that the practice of environmental management in South African-based firms increases the competitive advantage of the firm.

Environmental management practice in South Africa, however, primarily consists of the minimization of natural resources and as such lags international practice.

The literature survey indicates that international environmental management focuses on pollution prevention as opposed to pollution control in compliance with legislation (Sarkis and Rasheed 1995). Porter and van der Linde (1995) state that environmental improvement has traditionally focused on pollution control through the identification, processing and disposal of waste – a costly approach to environmental management. In recent years, more advanced companies and regulators have embraced the concept of pollution prevention, sometimes called source reduction, which uses closed-loop processes to limit pollution before it occurs. Pollution prevention therefore includes product life-cycle analysis, environmentally-friendly product design and process innovation (Hart 1997; Russo and Fouts 1997; Klassen and McLaughlin 1996).

Comparatively, South African-based firms follow an environmental strategy of pollution control which focuses on compliance with environmental legislation as opposed to a strategy of pollution prevention. Compliance with environmental legislation is costly and subsequently South African firms do not generate revenue from the implementation of environmental management. Shrivastava (1995) states that environmental regulations influence the competitive behaviour of firms by imposing new costs, investment demands and opportunities for improving production and energy efficiency. If, however, environmental regulations are prescriptive and inflexible it may cause firms to follow a compliance strategy and as such prohibit technical innovation

(Henderson 1994). Porter and van der Linde (1995a) state that business and governments have only focused on the cost of environmental regulation and have ignored the competitive benefit derived from it, namely the pressure on firms to innovate. The study conducted by the Department of Trade and Industry in 2003 "The Need for a South African Environmental Goods and Services Industry – First Draft Discussion Document 2003" found that South Africa lacks educated and experienced officials at the local government level that can create world-class legislation, enforce compliance with legislation and understand the relationship between environmental issues and the triple bottom line.

In South Africa, environmental management does, however, lead to competitive advantage for the firm. This **competitive advantage is not determined by technological innovation or the possession of intellectual capital: it is determined by the strength of the firm's relationships with its stakeholders**. In turn, top management determines the strength of these relationships. Klassen and McLaughlin (1996, p.2001) state that "corporate strategy determines the environmental orientation of the firm" and that a firm can establish an industry standard and create a potential barrier to the market if it creates partnerships with governmental bodies, policy makers and stakeholders. The top management of South African firms are clearly enforcing stakeholder relationships to promote competitive advantage for their firms.

7.4 Limitations of Research

Five limitations are present in the current study. First, the low response rate of 12.5% represented 125 respondents and Hatcher (1994) recommends a sample size of at least five times the number of test items in the research questionnaire for factor analysis. The construct reliability, however, was sufficiently high to continue with data analysis.

Second, the Ezeedex directory may not include all the registered South African companies in the specific sectors of this study and this may have created bias in the sampling design. Currently, Ezeedex is the most comprehensive directory of email contacts in South Africa and includes companies with an employee complement of (as low as) three.

Third, the participants of the expert panel were chosen for their knowledge of the environmental sector and excluded less informed yet affected subjects. This may have created bias in the design of the research questionnaire. High construct reliability indicated that respondents understood the questions and therefore bias was not present.

Fourth, path analysis assumes multivariate normal distribution of the variable indicators: in this study, all indicator variables did not display a normal distribution. "Structural equation modelling, however is still unbiased and efficient in the absence of multivariate normality if the residuals are multivariate normally distributed with means of 0 and if the residuals are not correlated with each other" (Structural Equation Modelling 2002, p. 43). The standardized residuals of the initial measurement model displayed properties of normal distribution (Output 5) – it was centered on zero and symmetrical about the centre and therefore the findings of this study are considered valid despite non normality of all indicator variables.

Fifth, the standardized factor loading of value 1 of V14 on F2 indicated that the factor F2 is completely measured by only one indicator variable. Also, the standard error of zero indicated that an estimation error is present: one variable is linearly dependent on another. These results call for a non-standard model. Programming of the non-standard model did not provide a good fit to the data and as such, the researcher worked with the standard model throughout the data analysis.

Finally, Hatcher (1994, p.201) states that data-driven modifications to causal models (as applied in this study) may result in a model that does not generalize to the population or other samples. As such, this research model should be considered tentative until it successfully survives additional tests in new samples.

8. RECOMMENDATIONS

8.1 Recommendations for South African-based Firms and Regulators

South African firms are taking the first steps towards gaining revenue from environmental management: this is indicated by the design of new products to minimize the effect on the environment. The use of preventative tools such as life-cycle analysis, however, is very limited in South African firms. Friedrich (2003) shows that, of the thirteen different life cycle analysis tools currently used in international firms, only four are currently used in South African firms.

In the 2004 South African National Budget, Finance Minister Trevor Manuel introduced pollution tax reforms for the first time to encourage the use of clean technology and thereby fine companies that pollute the environment (Naidoo, 2004). The taxes are not to be used punitively only – there are tax incentives for companies that conduct business in an environmentally-conscious manner.

If tools such as life-cycle analysis and design-for-the-environment are strengthened by investment in education and research and development, employees will gain technical expertise in proactive environmental management. Companies will then start to use their resources productively. Resource Productivity or Industrial Ecology was given a score of "very high priority and feasibility" by the South African Foresight Environmental Report published in 2002. The report gives the following suggestions to improve resource productivity in South Africa (2003, p.54):

1. Use the waste product of one company as the resource input of another.
2. Convert domestic and agricultural organic waste to chemical and enzymatic products through bio processing.
3. Extract minerals and potable water from wastewater of the mining industry and heavy industrial processes.

Once again, the report states that the lack of skilled human resources and commercially viable technology are the major constraints to resource productivity in South Africa.

This research clearly shows the strong positive influence top management commitment has on gaining competitive advantage from environmental management. Top management could promote technological innovation by implementing a strategy of pollution prevention as opposed to pollution control. Companies will then move away from the costly approach of conformance to environmental legislation to proactive innovation in response to environmental legislation.

Top management could also work closely with policy makers and government to encourage industry-specific environmental regulations. Environmental legislators should gain technical knowledge and training within specific sectors before setting environmental specifications. Also, it is unwise to adapt international legislation per se and enforce it on South African sectors. This was illustrated by the development of the Bamako Convention on the Ban of the Import of Hazardous Wastes into Africa and on the Control of their Transboundary Movements within Africa in 1998 (Tladi 2000). The Bamako Convention was developed due to the "perceived inadequacies of the Basel Convention in relation to developing countries, in particular the absence of a total ban on the export of hazardous and other wastes to African and other developing countries" (Naldi 2000, p.223).

Porter and van der Linde (1995a, p.124) suggest the following principles of regulatory design to promote innovation, resource productivity and competitiveness:

1. *Focus on outcomes, not technologies*. Regulation should not prescribe "best available technology" as remediation (for example, catalysts and scrubbers for air pollution). This prescription kills innovation.
2. *Enact strict rather than lax regulation*. Lax regulation promotes end-of-pipe solutions as opposed to rapid innovation.

3. *Regulate as close to the end user as practical, whilst encouraging upstream solutions*. This encourages product design that minimizes pollution before it occurs.
4. *Employ phase-in periods*. Give companies enough time to develop innovative solutions and link it to capital investment cycles. Short compliance deadlines are very costly to meet.
5. *Use market incentives*. Market incentives such as pollution charges and permits encourage creative use of technology.
6. *Harmonize or converge regulations in associated fields*. Ensure sector specific standards and don't generalize regulations across sectors.
7. *Develop regulations in sync with other countries*. If standards are too different in character from comparative standards in other countries, South African industry may innovate in the wrong direction.
8. *Make the regulatory process more stable and predictable*. Industry will exploit unstable regulatory processes by postponing solutions to pollution.
9. *Require industry participation in setting standards from the beginning*. Industry and regulators must trust each other and work towards useful and applicable environmental solutions.
10. *Develop strong technical capabilities among regulators*. Regulators must understand an industry's economics and what drives its competitiveness.
11. *Minimize the time and resources consumed by the regulation process itself*. Companies lose money if their permits are delayed. Promote self-regulation within firms.

Furthermore, the research indicates that communicating environmental performance strengthens stakeholder relationships and promotes competitive advantage. It would therefore benefit the company to measure its environmental performance financially and include this information in financial reports. Finally, benchmarking would provide opportunities for future investment: the Socially Responsible Index developed by the Johannesburg Stock Exchange provides the basis criteria for socially responsible business practise in South Africa.

8.2 Recommendations for Future Research

The empirical findings of this study show that environmental management drives competitive advantage in South African firms. Since this is the first study in South Africa to delineate the concepts environmental management and profitability and measure the causal nature of the concepts, it would benefit the research area if further empirical research were conducted to confirm or refute these findings. It is recommended that a larger sample size is used in future study. Also, since the model modifications were data-driven, it is important for the generalization of these findings that additional tests are performed in new samples.

Furthermore, the study could also be repeated after five years to determine if South African-based firms are moving from a compliance environmental strategy to a pollution prevention strategy. The study could perhaps focus on the success (or not) of fiscal incentives such as the tax reforms introduced in the 2004 National Budget.

APPENDIX A RESEARCH QUESTIONNAIRE

CONSTRUCT 1: TOP MANAGEMENT COMMITMENT		**Strongly Disagree 1**	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
1.	Top management drives and supports environmental initiatives within the firm.	1	2	3	4	5
2.	Our company has an environmental policy.	1	2	3	4	5
3.	Top management incorporates environmental initiatives into strategic business plans.	1	2	3	4	5
4.	Top management budgets for the implementation of environmental projects.	1	2	3	4	5
5.	Environmental protection is part of our corporate image.	1	2	3	4	5
6.	Our firm has a policy of regulatory environmental compliance.	1	2	3	4	5
7.	We develop and implement objectives for continuous environmental improvement.	1	2	3	4	5
8.	Top management reports on environmental performance in annual reports.	1	2	3	4	5
9.	The firm conducts internal environmental audits.	1	2	3	4	5
10.	We have implemented (or are in the process of implementing) a formal environmental management system in our firm (for example, ISO 14001).	1	2	3	4	5
11.	Our firm conducts market research to determine consumer needs for environmentally-friendly products.	1	2	3	4	5
12.	We invest in environmental research and development.	1	2	3	4	5
CONSTRUCT 2: PRODUCT & PROCESS TECHNOLOGY		**Strongly Disagree 1**	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
13.	Our firm recycles the waste (or some thereof) resulting from the use of its products after consumer use.	1	2	3	4	5

14.	Our firm designs new products to minimize the product's environmental impact.	1	2	3	4	5
15.	We apply product life-cycle analysis in our firm.	1	2	3	4	5
16.	We modify our production system to reduce pollution.	1	2	3	4	5
17.	The firm treats its wastes (air emissions, effluents and solid waste) before discharge into the environment.	1	2	3	4	5
18.	We implement end-of-pipe technology to reduce pollution.	1	2	3	4	5
19.	We measure and monitor the quantity and quality of air emissions, effluents and waste generated by our process.	1	2	3	4	5
CONSTRUCT 3: RISK MANAGEMENT		1	2	3	4	5
20.	Our firm has been involved in environmental legal proceedings.	1	2	3	4	5
21.	We have external, independent environmental audits conducted on our processes.	1	2	3	4	5
22.	Our firm modifies its' production process or products to comply with environmental legislation.	1	2	3	4	5
23.	We comply with environmental legislation to enhance international trading.	1	2	3	4	5
24.	Environmental regulation is a major concern of our firm.	1	2	3	4	5
CONSTRUCT 4: STAKEHOLDER PARTNERSHIPS						
25.	Our firm actively engages with government to comply with environmental legislation.	1	2	3	4	5
26.	We only purchase goods from environmentally-conscious suppliers.	1	2	3	4	5
27.	Our firm promotes environmental partnerships with the community.	1	2	3	4	5

28.	We provide environmental management training for our suppliers.	1	2	3	4	5
29.	Our firm conducts environmental impact assessments before commencing construction or activity that may impact on the environment.	1	2	3	4	5
30.	We communicate our firm's environmental performance data with stakeholders.	1	2	3	4	5
31.	We provide technical training for contractors with regard to our environmental requirements.					
CONSTRUCT 5: RESOURCE CONSERVATION		**Strongly Disagree 1**	**Disagree 2**	**Neutral 3**	**Agree 4**	**Strongly Agree 5**
32.	We measure and monitor the firm's consumption of resources, including water, energy and land.	1	2	3	4	5
33.	The firm communicates resource consumption with the stakeholders in financial terms.	1	2	3	4	5
34.	We implement programs to minimize the consumption of resources on an on-going basis.	1	2	3	4	5
35.	We actively promote environmental conservation (or contribute financially towards conservation).	1	2	3	4	5
CONSTRUCT 6: EMPLOYEE RELATIONS						
36.	Environmental conservation is a value held strongly by our employees.	1	2	3	4	5
37.	Our employees make suggestions to improve the environmental performance of the firm.	1	2	3	4	5
38.	We contain the technical expertise within the firm to modify industrial processes in order to reduce waste and pollution.	1	2	3	4	5
39.	Key personnel are appointed for environmental issues.	1	2	3	4	5
40.	We provide environmental management training for our employees.	1	2	3	4	5
41.	Employees are rewarded for superior environmental performance.	1	2	3	4	5

CONSTRUCT 7: RETURN ON INVESTMENT		Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5
42.	Environmental management leads to significant cost advantages for our firm.	1	2	3	4	5
43.	The firm has reduced its' use of resources, including water, electricity and land, thereby saving input costs.	1	2	3	4	5
44.	We measure the return-on-investment of our environmental initiatives.	1	2	3	4	5
45.	Environmental management has cost the firm a significant amount of money.	1	2	3	4	5
46.	We measure the profit gained from environmental initiatives.	1	2	3	4	5
47.	We measure the opportunity costs of pollution, such as wasted raw material and wasted human effort.	1	2	3	4	5
48.	The firm has achieved significant cost savings by applying product life-cycle analysis.	1	2	3	4	5
49.	Implementation of end-of-pipe technology has increased our operating costs.	1	2	3	4	5
50.	We receive revenue from the use of our byproducts as raw materials by other firms.	1	2	3	4	5
51.	Continuous environmental improvement generates revenue for the firm.	1	2	3	4	5
52.	Environmental audits have identified opportunities for cost saving within the firm.	1	2	3	4	5
CONSTRUCT 8: INTELLECTUAL CAPITAL						
53.	Our firm holds intellectual capital because we have developed environmental patents for our process and product.	1	2	3	4	5
54.	Compliance with regulation has led to innovation within the firm.	1	2	3	4	5
55.	Our employees have redesigned (or made suggestions for the redesign of) products and processes in order to reduce waste and pollution and increase productivity.	1	2	3	4	5

CONSTRUCT 9: COMPETITIVE ADVANTAGE						
56.	Our firm has entered lucrative new markets by adopting environmental strategies.	1	2	3	4	5
57.	We have reduced financial risk (e.g. industrial accidents, lawsuits, consumer boycotts and company closure) by complying with environmental regulations.	1	2	3	4	5
58.	Our firm has created barrier-to-market entry with our proactive relationships with policy makers.	1	2	3	4	5
59.	Compliance with legislation has allowed us to compete in international markets.	1	2	3	4	5
60.	Recycling post-consumer waste enhances our "green" corporate image.	1	2	3	4	5
61.	We have gained tax benefits by complying with environmental legislation.	1	2	3	4	5
62.	We have developed strong relationships with stakeholders by communicating environmental performance data.	1	2	3	4	5
63.	Our employees share our environmental values and this promotes their commitment to the firm.	1	2	3	4	5
64.	Our firm has gained market share by reporting on environmental performance.	1	2	3	4	5

APPENDIX B ENVIRONMENTAL MANAGEMENT AND PROFITABILITY ONLINE ADMINISTRATION

APPENDIX C LETTER TO EXPERT PANEL

APPENDIX D FIRST EMAIL CORRESPONDENCE WITH RESPONDENTS

23 January 2004

ATTENTION: MR. E. SMART
AFRICAN PIONEER MINING

Dear Mr. Smart,

POSTGRADUATE RESEARCH REQUEST

I am currently conducting research on the relationship between Environmental Management and Profitability in South African-based firms. The survey is part of a research project which is in partial fulfillment of a Master of Science degree at the Department of Industrial Engineering, University of the Witwatersrand .

You have been selected as a participant in this work. The information you provide will help us to better understand the role environmental management plays in determining profitability in a firm operating in South Africa.

I will greatly appreciate your time and effort in completing this research questionnaire! It should take you approximately twenty minutes to complete. Please click on the following link to access the research web page and then follow the corresponding link to the research questionnaire:

http://www.wits.ac.za/environment

In order to access the website, please type in the following words in *lower case* when prompted:

User name: research
Password: reply

Your response will be kept *strictly confidential*. To ensure confidentiality, I have coded your response and only the response code will be used in analysis of the data. Your personal response code is **3.** You will be requested to type in this number at the end of the questionnaire (Question 71). Only members of the research team will have access to the information you give.

I would greatly appreciate it if you could return the completed questionnaire by the 30th January 2004; just click on the SUBMIT button at the end of the questionnaire to return it to me.

If you have any questions or inquiries regarding the research project, please contact me or my supervisor, Dr. Harold Campbell. Our contact details are provided below.

Thank-you for your time and assistance in furthering this research endeavour!

Best regards,
Hannelie Nel

Hannelie Nel	Dr. Harold Campbell
(011) 406 2707	(011) 717 7367
hannnel@mail.twr.ac.za	hcampbell@mech.wits.ac.za

APPENDIX E FIRST REMINDER EMAIL TO RESPONDENTS

18 February 2004

PERSONAL RESPONSE CODE: 393

Dear Participant,

RESEARCH REQUEST

I have not received sufficient responses to finalize my research, so it would be of great help to me if you would take the time to complete the research questionnaire! It should take you approximately twenty minutes to complete. The following link provides direct access the web page:

http://www.wits.ac.za/environment

In order to access the website, please type in the following words in *lower case* when prompted:

User name: research
Password: reply

Your response will be kept *strictly confidential*. Only members of the research team will have access to the information you give.

I would greatly appreciate it if you could return the completed questionnaire by the 25th February 2004; just click on the SUBMIT button at the end of the questionnaire to return it to me.

If you have any questions or inquiries regarding the research project, please contact me or my supervisor, Dr. Harold Campbell. Our contact details are provided below.

Thank-you for your time and assistance in furthering this research endeavour!

Best regards,
Hannelie Nel

Hannelie Nel	Dr. Harold Campbell
(011) 406 2707	(011) 717 7367
hannnel@mail.twr.ac.za	hcampbell@mech.wits.ac.za

APPENDIX F PROC CALIS PROGRAM: INITIAL MEASUREMENT MODEL

```
Libname dat "a:\Environment";

PROC CALIS dat=dat.environment COVARIANCE CORR RESIDUAL
MODIFICATION;

LINEQS

V1=LV1F1 F1 + E1,
V2=LV2F1 F1 + E2,
V3=LV3F1 F1 + E3,
V4=LV4F1 F1 + E4,
V5=LV5F1 F1 + E5,
V6=LV6F1 F1 + E6,
V7=LV7F1 F1 + E7,
V8=LV8F1 F1 + E8,
V9=LV9F1 F1 + E9,
V10=LV10F1 F1 + E10,
V11=LV11F1 F1 + E11,
V12=LV12F1 F1 + E12,
V13=LV13F2 F2 + E13,
V14=LV14F2 F2 + E14,
V15=LV15F2 F2 + E15,
V16=LV16F2 F2 + E16,
V17=LV17F2 F2 + E17,
V18=LV18F2 F2 + E18,
V19=LV19F2 F2 + E19,
V20=LV20F3 F3 + E20,
V21=LV21F3 F3 + E21,
V22=LV22F3 F3 + E22,
V23=LV23F3 F3 + E23,
V24=LV24F3 F3 + E24,
V25=LV25F4 F4 + E25,
V26=LV26F4 F4 + E26,
V27=LV27F4 F4 + E27,
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V29=LV29F4 F4 + E29,
V30=LV30F4 F4 + E30,
V31=LV31F4 F4 + E31,
V32=LV32F5 F5 + E32,
V33=LV33F5 F5 + E33,
V34=LV34F5 F5 + E34,
V35=LV35F5 F5 + E35,
V36=LV36F6 F6 + E36,
V37=LV37F6 F6 + E37,
V38=LV38F6 F6 + E38,
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V40=LV40F6 F6 + E40,
V41=LV41F6 F6 + E41,
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V43=LV43F7 F7 + E43,
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V45=LV45F7 F7 + E45,
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V48=LV48F7 F7 + E48,
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V51=LV51F7 F7 + E51,
V52=LV52F7 F7 + E52,
V53=LV53F8 F8 + E53,
V54=LV54F8 F8 + E54,
V55=LV55F8 F8 + E55,
V56=LV56F9 F9 + E56,
V57=LV57F9 F9 + E57,
V58=LV58F9 F9 + E58,
V59=LV59F9 F9 + E59,
V60=LV60F9 F9 + E60,
V61=LV61F9 F9 + E61,
V62=LV62F9 F9 + E62,
V63=LV63F9 F9 + E63,
V64=LV64F9 F9 + E64;
STD
F1=1,
F2=1,
F3=1,
F4=1,
F5=1,
F6=1,
F7=1,
F8=1,
F9=1,
E1-E64=VARE1-VARE64;
COV
F1 F2=CF1F2,
F1 F3=CF1F3,
F1 F4=CF1F4,
F1 F5=CF1F5,
F1 F6=CF1F6,
F1 F7=CF1F7,
F1 F8=CF1F8,
F1 F9=CF1F9,
F2 F3=CF2F3,
F2 F4=CF2F4,
F2 F5=CF2F5,
F2 F5=CF2F5,
F2 F6=CF2F6,
F2 F7=CF2F7,
F2 F8=CF2F8,
F2 F9=CF2F9,
```

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F3 F4=CF3F4,
F3 F5=CF3F5,
F3 F6=CF3F6,
F3 F7=CF3F7,
F3 F8=CF3F8,
F3 F9=CF3F9,
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F4 F6=CF4F6,
F4 F7=CF4F7,
F4 F8=CF4F8,
F4 F9=CF4F9,
F5 F6=CF5F6,
F5 F7=CF5F7,
F5 F8=CF5F8,
F5 F9=CF5F9,
F6 F7=CF6F7,
F6 F8=CF6F8,
F6 F9=CF6F9,
F7 F8=CF7F8,
F7 F9=CF7F9,
F8 F9=CF8F9;
VAR V1-V64;
RUN;
```

APPENDIX G PEARSON CORRELATION COEFFICIENT MATRIX

APPENDIX H PROC CALIS PROGRAM: ITERATION 14

```
Libname dat "a:\Environment";

PROC CALIS data=dat.environment COVARIANCE CORR RESIDUAL
MODIFICATION;

LINEQS

V1=LV1F1 F1 + E1,
V4=LV4F1 F1 + E4,
V10=LV10F1 F1 + E10,
V14=LV14F2 F2 + E14,
V21=LV21F1 F1 + E21,
V24=LV24F1 F1 + E24,
V27=LV27F4 F4 + E27,
V30=LV30F4 F4 + E30,
V31=LV31F4 F4 + E31,
V33=LV33F5 F5 + E33,
V34=LV34F5 F5 + E34,
V43=LV43F5 F5 + E43,
V39=LV39F1 F1 + E39,
V40=LV40F1 F1 + E40,
V42=LV42F9 F9 + E42,
V52=LV52F9 F9 + E52,
V58=LV58F9 F9 + E58,
V59=LV59F9 F9 + E59,
V62=LV62F4 F4 + E62,
V64=LV64F9 F9 + E64;
STD
F1=1,
F2=1,
F4=1,
F5=1,
F9=1,
E1=VARE1,
E4=VARE4,
E10=VARE10,
E14=VARE14,
E21=VARE21,
E24=VARE24,
E27=VARE27,
E30=VARE30,
E31=VARE31,
E33=VARE33,
E34=VARE34,
E39=VARE39,
E40=VARE40,
E42=VARE42,
E43=VARE43,
```

```
E52=VARE52,
E58=VARE58,
E59=VARE59,
E62=VARE62,
E64=VARE64;
COV
F1 F2=CF1F2,
F1 F4=CF1F4,
F1 F5=CF1F5,
F1 F9=CF1F9,
F2 F4=CF2F4,
F2 F5=CF2F5,
F2 F9=CF2F9,
F4 F5=CF4F5,
F4 F9=CF4F9,
F5 F9=CF5F9;
VAR V1;
VAR V4;
VAR V10;
VAR V14;
VAR V21;
VAR V24;
VAR V27;
VAR V30;
VAR V31;
VAR V33;
VAR V34;
VAR V39;
VAR V40;
VAR V42;
VAR V43;
VAR V52;
VAR V58;
VAR V59;
VAR V62;
VAR V64;
RUN;
```

APPENDIX I EIGENVALUES AND INTERPRETABILITY CRITERIA

1. EIGENVALUES

The scree plot for the final revised measurement model is given in Figure 27. The scree plot shows the retained factors with corresponding eigenvalues. The Kaiser-Guttman rule states that factors with eigenvalues greater or equal to 1 should be retained or the factors that contribute to a cumulative proportion of 1 should be retained (Nunnally and Bernstein 1994).

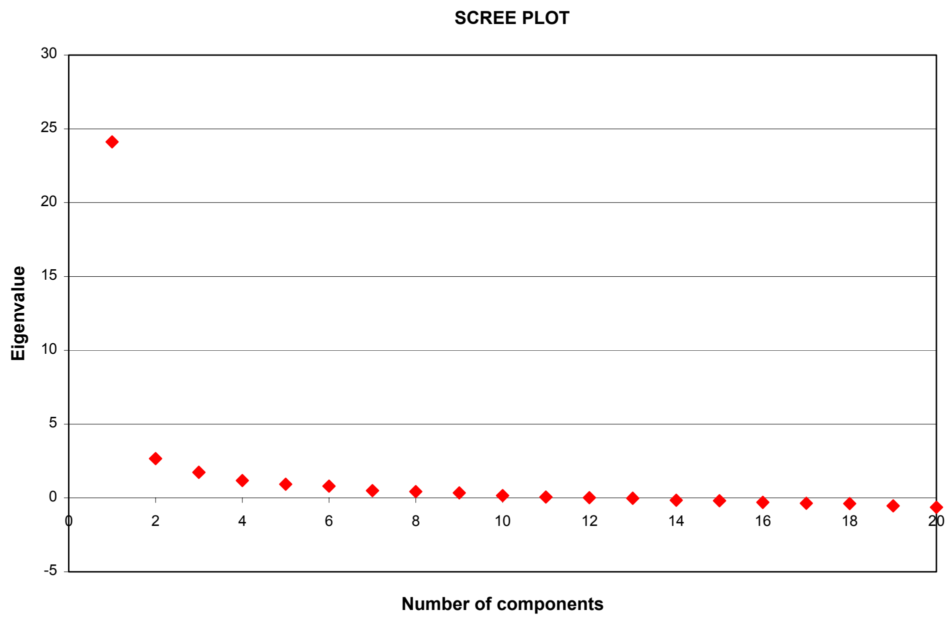
Table 16 shows the eigenvalues of the retained components in the first column and the cumulative proportion values in the last column. From the table it is evident that 5 factors were retained using the proportion criterion (as in the final revised measurement model).

Table 16 Eigenvalues of retained components: final revised measurement model

	Eigenvalue	Difference	Proportion	Cumulative
1	24.1124709	21.4499841	0.7949	0.7949
2	2.6624868	0.9235268	0.0878	0.8826
3	1.7389600	0.5698364	0.0573	0.9399
4	1.1691236	0.2373450	0.0385	0.9785
5	0.9317785	0.1397244	0.0307	1.0092
6	0.7920542	0.3030663	0.0261	1.0353
7	0.4889878	0.0624516	0.0161	1.0514
8	0.4265362	0.0867087	0.0141	1.0655
9	0.3398275	0.1791060	0.0112	1.0767
10	0.1607215	0.0929252	0.0053	1.0820
11	0.0677963	0.0525417	0.0022	1.0842
12	0.0152546	0.0391108	0.0005	1.0847
13	-0.0238562	0.1253850	-0.0008	1.0839
14	-0.1492412	0.0382445	-0.0049	1.0790
15	-0.1874857	0.1110175	-0.0062	1.0728
16	-0.2985032	0.0644717	-0.0098	1.0630
17	-0.3629749	0.0235371	-0.0120	1.0510
18	-0.3865120	0.1495240	-0.0127	1.0383
19	-0.5360359	0.0897235	-0.0177	1.0206
20	-0.6257595		-0.0206	1.0000
5 factors will be retained by the PROPORTION criterion.				

The scree plot of eigenvalues is given in Figure 27. The plot shows a major break after eigenvector 1 which means that this vector accounts for 79% of the total variance in the data. Furthermore eigenvectors 1 to 5 account for 100% of the variance in the data.

Figure 27 Scree plot: final revised measurement model



2. INTERPRETABILITY CRITERIA

Finally, the constructs and indicator variables of the final revised measurement model are given below. Hatcher (1994, p.30) suggests that the researcher tests the final solution against the following interpretability criteria:

- Are there at least three items with significant loadings on each retained factor?
- Do the variables that load on a given factor share the same conceptual meaning?
- Do the variables that load on different constructs seem to be measuring different constructs?

The final measurement model does not satisfy the first criterion because factor F2 is measured by only one indicator variable V14. As discussed, the researcher continued data analysis with the standard model.

It is interesting to note that the analysis confirmed that <u>contractors</u> form part of the stakeholders of the firm (indicated by V31 loading on F4).

F9 COMPETITIVE ADVANTAGE

V42: Environmental management leads to significant cost advantages for our firm.

V52: Environmental audits have identified opportunities for cost saving within the firm.

V58: Our firm has created barrier-to-market entry with our proactive relationships with policy makers.

V59: Compliance with legislation has allowed us to compete in international markets.

V64: Our firm has gained market share by reporting on environmental performance.

F1 TOP MANAGEMENT COMMITMENT

V1: Top management drives and supports environmental initiatives within the firm.

V4: Top management budgets for the implementation of environmental projects.

V10: We have implemented (or are in the process of implementing) a formal environmental management system (for example, ISO 14001).

V21: We have external, independent audits conducted on our processes.

V24: Environmental regulation is a major concern for our firm.

V39: Key personnel are appointed for environmental issues.

V40: We provide environmental management training for our employees.

F2 PRODUCT AND PROCESS TECHNOLOGY

V14: Our firm designs new products to minimize the product's environmental impact.

F4 STAKEHOLDER PARTNERSHIPS

V27: Our firm promotes environmental partnerships with the community.

V30: We communicate our firm's environmental performance with stakeholders.

V31: We provide technical training for contractors with regard to our environmental requirements.

V62: We have developed strong relationships with stakeholders by communicating environmental performance data.

F5 RESOURCE CONSERVATION

V33: The firm communicates resource consumption with stakeholders in financial terms.

V34: We implement programs to minimize the consumption of resources on an on-going basis.

V43: The firm reduces its use of resources, including water, electricity and land, thereby saving input costs.

APPENDIX J PROC CALIS PROGRAM: THEORETICAL MODEL

```
Libname dat "a:\Environment";

PROC CALIS data=dat.environment COVARIANCE CORR RESIDUAL
MODIFICATION;

LINEQS
```

```
V1=F1 + E1,
V4=LV4F1 F1 + E4,
V10=LV10F1 F1 + E10,
V14=F2 + E14,
V21=LV21F1 F1 + E21,
V24=LV24F1 F1 + E24,
V27=F4 + E27,
V30=LV30F4 F4 + E30,
V31=LV31F4 F4 + E31,
V33=F5 + E33,
V34=LV34F5 F5 + E34,
V43=LV43F5 F5 + E43,
V39=LV39F1 F1 + E39,
V40=LV40F1 F1 + E40,
V42=F9 + E42,
V52=LV52F9 F9 + E52,
V58=LV58F9 F9 + E58,
V59=LV59F9 F9 + E59,
V62=LV62F4 F4 + E62,
V64=LV64F9 F9 + E64,
F9=PF9F1 F1+PF9F2 F2+PF9F4 F4+PF9F5 F5 + D9;
STD
F1=VARF1,
F2=VARF2,
F4=VARF4,
F5=VARF5,
D9=VARD9,
E1=VARE1,
E4=VARE4,
E10=VARE10,
E14=VARE14,
E21=VARE21,
E24=VARE24,
E27=VARE27,
E30=VARE30,
E31=VARE31,
E33=VARE33,
E34=VARE34,
E39=VARE39,
E40=VARE40,
E42=VARE42,
E43=VARE43,
E52=VARE52,
E58=VARE58,
E59=VARE59,
E62=VARE62,
E64=VARE64;
COV
F1 F2=CF1F2,
F1 F4=CF1F4,
F1 F5=CF1F5,
```

```
F2 F4=CF2F4,
F2 F5=CF2F5,
F4 F5=CF4F5;
VAR V1;
VAR V4;
VAR V10;
VAR V14;
VAR V21;
VAR V24;
VAR V27;
VAR V30;
VAR V31;
VAR V33;
VAR V34;
VAR V39;
VAR V40;
VAR V42;
VAR V43;
VAR V52;
VAR V58;
VAR V59;
VAR V62;
VAR V64;
RUN;
```

APPENDIX K PROC CALIS PROGRAM: FINAL CAUSAL MODEL

```
Libname dat "a:\Environment";

PROC CALIS data=dat.environment COVARIANCE CORR RESIDUAL
MODIFICATION;

LINEQS

V1=F1 + E1,
V4=LV4F1 F1 + E4,
V10=LV10F1 F1 + E10,
V14=F2 + E14,
V21=LV21F1 F1 + E21,
V24=LV24F1 F1 + E24,
V27=F4 + E27,
V30=LV30F4 F4 + E30,
V31=LV31F4 F4 + E31,
V33=F5 + E33,
V34=LV34F5 F5 + E34,
V43=LV43F5 F5 + E43,
V39=LV39F1 F1 + E39,
V40=LV40F1 F1 + E40,
```

```
V42=F9 + E42,
V52=LV52F9 F9 + E52,
V58=LV58F9 F9 + E58,
V59=LV59F9 F9 + E59,
V62=LV62F4 F4 + E62,
V64=LV64F9 F9 + E64,
F9=PF9F4 F4+D9,
F4=PF4F1 F1+D4;
STD
F1=VARF1,
F2=VARF2,
F5=VARF5,
D4=VARD4,
D9=VARD9,
E1=VARE1,
E4=VARE4,
E10=VARE10,
E14=VARE14,
E21=VARE21,
E24=VARE24,
E27=VARE27,
E30=VARE30,
E31=VARE31,
E33=VARE33,
E34=VARE34,
E39=VARE39,
E40=VARE40,
E42=VARE42,
E43=VARE43,
E52=VARE52,
E58=VARE58,
E59=VARE59,
E62=VARE62,
E64=VARE64;
COV
F1 F2=CF1F2,
F1 F5=CF1F5,
F2 F5=CF2F5;
VAR V1;
VAR V4;
VAR V10;
VAR V14;
VAR V21;
VAR V24;
VAR V27;
VAR V30;
VAR V31;
VAR V33;
VAR V34;
VAR V39;
VAR V40;
```

```
VAR V42;
VAR V43;
VAR V52;
VAR V58;
VAR V59;
VAR V62;
VAR V64;
RUN;
```

APPENDIX L EQUATIONS FOR PARSIMONY AND MODEL FIT INDICES

Parsimony Ratio

$$PR = \frac{df_J}{df_o}$$

Parsimonious Fit Index (PNFI)

PNFI = (PR) x (NFI)

Relative Normed Fit Index (RNFI)

$$RNFI = \frac{F_u - F_j}{F_u - F_m - (df_J - df_M)}$$

Relative Parsimony Ratio (RPR)

$$RPR = \frac{df_J - df_M}{df_U - df_M}$$

Relative Parsimonious-Fit Index (RPFI)

RPFI = (RNFI) x (RPR)

Where:

df_J = degrees of freedom for the model of interest

df_O = degrees of freedom for the null model

df_M = degrees of freedom for the measurement model

df_U = degrees of freedom for the uncorrelated factors model

F_U = model chi-square for the uncorrelated factors model

F_j = model chi-square for the model of interest

F_m = model chi-square for the measurement model

APPENDIX M UNIVARIATE ANALYSIS

The UNIVARIATE Procedure

Variable: V1

Moments

N	125	Sum Weights	125
Mean	4.28	Sum Observations	535
Std Deviation	0.86695611	Variance	0.7516129
Skewness	-1.6354683	Kurtosis	3.21937979
Uncorrected SS	2383	Corrected SS	93.2
Coeff Variation	20.255984	Std Error Mean	0.07754291

Basic Statistical Measures

Location		Variability	
Mean	4.280000	Std Deviation	0.86696
Median	4.000000	Variance	0.75161
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	55.19524	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.72001	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.277359	Pr > D	<0.0100
Cramer-von Mises	W-Sq	2.128741	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	12.52577	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V2

Moments

N	125	Sum Weights	125
Mean	4.048	Sum Observations	506
Std Deviation	1.098797	Variance	1.20735484
Skewness	-1.0969989	Kurtosis	0.28239823
Uncorrected SS	2198	Corrected SS	149.712
Coeff Variation	27.1441946	Std Error Mean	0.09827939

Basic Statistical Measures

Location		Variability	
Mean	4.048000	Std Deviation	1.09880
Median	4.000000	Variance	1.20735
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	41.1887	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.784993	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.266578	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.748381	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	10.46006	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V3

Moments

N	125	Sum Weights	125
Mean	3.84	Sum Observations	480
Std Deviation	1.0112273	Variance	1.02258065
Skewness	-0.7182574	Kurtosis	-0.3182051
Uncorrected SS	1970	Corrected SS	126.8
Coeff Variation	26.3340442	Std Error Mean	0.09044692

Basic Statistical Measures

Location		Variability	
Mean	3.840000	Std Deviation	1.01123
Median	4.000000	Variance	1.02258
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	42.45584	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.836524	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.29086	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.513889	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.419966	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V4

Moments

N	125	Sum Weights	125
Mean	3.816	Sum Observations	477
Std Deviation	1.00309199	Variance	1.00619355
Skewness	-0.8879269	Kurtosis	0.32899903
Uncorrected SS	1945	Corrected SS	124.768
Coeff Variation	26.2864778	Std Error Mean	0.08971928

Basic Statistical Measures

Location		Variability	
Mean	3.816000	Std Deviation	1.00309
Median	4.000000	Variance	1.00619
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	42.53267	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.834497	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.308771	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.710203	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.745451	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V5

Moments

N	125	Sum Weights	125
Mean	3.72	Sum Observations	465
Std Deviation	1.34763832	Variance	1.81612903
Skewness	-0.7403351	Kurtosis	-0.7625945
Uncorrected SS	1955	Corrected SS	225.2
Coeff Variation	36.2268365	Std Error Mean	0.12053644

Basic Statistical Measures

Location		Variability	
Mean	3.720000	Std Deviation	1.34764
Median	4.000000	Variance	1.81613
Mode	5.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.86204	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.822178	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.246296	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.369714	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.389818	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V6

Moments

N	125	Sum Weights	125
Mean	4.056	Sum Observations	507
Std Deviation	0.98622774	Variance	0.97264516
Skewness	-1.0874911	Kurtosis	0.71283379
Uncorrected SS	2177	Corrected SS	120.608
Coeff Variation	24.3152797	Std Error Mean	0.08821089

Basic Statistical Measures

Location		Variability	
Mean	4.056000	Std Deviation	0.98623
Median	4.000000	Variance	0.97265
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	45.98072	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.803411	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.277359	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.62721	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.396231	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V7

Moments

N	125	Sum Weights	125
Mean	3.792	Sum Observations	474
Std Deviation	1.01834781	Variance	1.03703226
Skewness	-0.9206679	Kurtosis	0.24493453
Uncorrected SS	1926	Corrected SS	128.592
Coeff Variation	26.8551637	Std Error Mean	0.0910838

Basic Statistical Measures

Location		Variability	
Mean	3.792000	Std Deviation	1.01835
Median	4.000000	Variance	1.03703
Mode	4.000000	Range	4.00000
		Interquartile Range	0

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	41.63199	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.814776	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.332922	Pr > D	<0.0100
Cramer-von Mises	W-Sq	2.048132	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	10.32031	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

B

Moments

N	125	Sum Weights	125
Mean	3.344	Sum Observations	418
Std Deviation	1.17846264	Variance	1.38877419
Skewness	-0.1292335	Kurtosis	-1.1144846
Uncorrected SS	1570	Corrected SS	172.208
Coeff Variation	35.2411077	Std Error Mean	0.1054049

Basic Statistical Measures

Location		Variability	
Mean	3.344000	Std Deviation	1.17846
Median	3.000000	Variance	1.38877
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	31.72528	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.89108	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.207119	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.839254	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.314481	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V9

Moments

N	125	Sum Weights	125
Mean	3.776	Sum Observations	472
Std Deviation	1.09885571	Variance	1.20748387
Skewness	-0.6916611	Kurtosis	-0.4367183
Uncorrected SS	1932	Corrected SS	149.728
Coeff Variation	29.1010516	Std Error Mean	0.09828464

Basic Statistical Measures

Location		Variability	
Mean	3.776000	Std Deviation	1.09886
Median	4.000000	Variance	1.20748
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.41902	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.852146	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.268764	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.261792	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.283136	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V10

Moments

N	125	Sum Weights	125
Mean	3.568	Sum Observations	446
Std Deviation	1.3218755	Variance	1.74735484
Skewness	-0.351684	Kurtosis	-1.3059489
Uncorrected SS	1808	Corrected SS	216.672
Coeff Variation	37.0480802	Std Error Mean	0.11823214

Basic Statistical Measures

Location		Variability	
Mean	3.568000	Std Deviation	1.32188
Median	4.000000	Variance	1.74735
Mode	5.000000	Range	4.00000
		Interquartile Range	3.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.17792	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.843609	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.204664	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.14124	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.586345	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V11

Moments

N	125	Sum Weights	125
Mean	2.904	Sum Observations	363
Std Deviation	1.05052982	Variance	1.1036129
Skewness	0.10973081	Kurtosis	-0.7918369
Uncorrected SS	1191	Corrected SS	136.848
Coeff Variation	36.1752693	Std Error Mean	0.09396224

Basic Statistical Measures

Location		Variability	
Mean	2.904000	Std Deviation	1.05053
Median	3.000000	Variance	1.10361
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.90603	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.902565	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.205248	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.915748	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.395371	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V12

Moments

N	125	Sum Weights	125
Mean	2.968	Sum Observations	371
Std Deviation	1.22432338	Variance	1.49896774
Skewness	-0.0721317	Kurtosis	-1.1648306
Uncorrected SS	1287	Corrected SS	185.872
Coeff Variation	41.2507878	Std Error Mean	0.10950681

Basic Statistical Measures

Location		Variability	
Mean	2.968000	Std Deviation	1.22432
Median	3.000000	Variance	1.49897
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	27.10334	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.890279	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.224362	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.973695	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.723959	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V13

Moments

N	125	Sum Weights	125
Mean	3.544	Sum Observations	443
Std Deviation	1.24760416	Variance	1.55651613
Skewness	-0.6208733	Kurtosis	-0.7944587
Uncorrected SS	1763	Corrected SS	193.008
Coeff Variation	35.2032775	Std Error Mean	0.11158911

Basic Statistical Measures

Location		Variability	
Mean	3.544000	Std Deviation	1.24760
Median	4.000000	Variance	1.55652

Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	31.75937	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.84472	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.298631	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.523498	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.19918	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V14

Moments

N	125	Sum Weights	125
Mean	3.352	Sum Observations	419
Std Deviation	1.08699052	Variance	1.18154839
Skewness	-0.205275	Kurtosis	-0.8885234
Uncorrected SS	1551	Corrected SS	146.512
Coeff Variation	32.4281181	Std Error Mean	0.09722339

Basic Statistical Measures

Location		Variability	
Mean	3.352000	Std Deviation	1.08699
Median	4.000000	Variance	1.18155
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	34.4773	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.895597	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.22846	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.934885	Pr > W-Sq	<0.0050

Anderson-Darling	A-Sq	5.490076	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V15

Moments

N	125	Sum Weights	125
Mean	2.984	Sum Observations	373
Std Deviation	1.02378173	Variance	1.04812903
Skewness	-0.2425803	Kurtosis	-0.9800402
Uncorrected SS	1243	Corrected SS	129.968
Coeff Variation	34.3090392	Std Error Mean	0.09156982

Basic Statistical Measures

Location		Variability	
Mean	2.984000	Std Deviation	1.02378
Median	3.000000	Variance	1.04813
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	32.58716	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.87226	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.231499	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.133407	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.112246	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V16

Moments

N	125	Sum Weights	125
Mean	3.88	Sum Observations	485
Std Deviation	1.05951906	Variance	1.12258065
Skewness	-0.955533	Kurtosis	0.32728585
Uncorrected SS	2021	Corrected SS	139.2
Coeff Variation	27.3071923	Std Error Mean	0.09476627

Basic Statistical Measures

Location Variability

Mean	3.880000	Std Deviation	1.05952
Median	4.000000	Variance	1.12258
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	40.94284	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.830371	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.289087	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.503213	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.246471	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V17

Moments

N	125	Sum Weights	125
Mean	3.912	Sum Observations	489
Std Deviation	0.94199514	Variance	0.88735484
Skewness	-0.8222901	Kurtosis	0.45581442
Uncorrected SS	2023	Corrected SS	110.032
Coeff Variation	24.0796303	Std Error Mean	0.08425461

Basic Statistical Measures

Location		Variability	
Mean	3.912000	Std Deviation	0.94200
Median	4.000000	Variance	0.88735
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	46.4307	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.847343	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.273215	Pr > D	<0.0100

Cramer-von Mises	W-Sq 1.413152	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq 7.582311	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V18

Moments

N	125	Sum Weights	125
Mean	3.424	Sum Observations	428
Std Deviation	0.97768654	Variance	0.95587097
Skewness	-0.3621509	Kurtosis	-0.4509183
Uncorrected SS	1584	Corrected SS	118.528
Coeff Variation	28.5539293	Std Error Mean	0.08744694

Basic Statistical Measures

Location		Variability	
Mean	3.424000	Std Deviation	0.97769
Median	4.000000	Variance	0.95587
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	39.15517	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.88922	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.250118	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.161447	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.297577	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V19

Moments

N	125	Sum Weights	125
Mean	3.704	Sum Observations	463
Std Deviation	1.1218073	Variance	1.25845161
Skewness	-0.7151471	Kurtosis	-0.454267
Uncorrected SS	1871	Corrected SS	156.048
Coeff Variation	30.2863741	Std Error Mean	0.1003375

Basic Statistical Measures

Location Variability

Mean	3.704000	Std Deviation	1.12181
Median	4.000000	Variance	1.25845
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	36.91541	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.840926	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.300056	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.555095	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.424099	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V20

Moments

N	124	Sum Weights	124
Mean	2.16935484	Sum Observations	269
Std Deviation	1.14566538	Variance	1.31254917
Skewness	0.81534433	Kurtosis	-0.2174656
Uncorrected SS	745	Corrected SS	161.443548
Coeff Variation	52.8113412	Std Error Mean	0.10288379

Basic Statistical Measures

Location		Variability	
Mean	2.169355	Std Deviation	1.14567
Median	2.000000	Variance	1.31255
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	21.08549	Pr > |t|	<.0001
Sign	M	62	Pr >= |M|	<.0001
Signed Rank	S	3875	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.843941	Pr < W	<0.0001

Kolmogorov-Smirnov	D	0.252307	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.203159	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.181009	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V21

Moments

N	125	Sum Weights	125
Mean	3.648	Sum Observations	456
Std Deviation	1.21983605	Variance	1.488
Skewness	-0.6759443	Kurtosis	-0.6650821
Uncorrected SS	1848	Corrected SS	184.512
Coeff Variation	33.4384883	Std Error Mean	0.10910545

Basic Statistical Measures

Location		Variability	
Mean	3.648000	Std Deviation	1.21984
Median	4.000000	Variance	1.48800
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	33.43554	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.844851	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.285542	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.401213	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.842189	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V22

Moments

N	125	Sum Weights	125
Mean	4.024	Sum Observations	503
Std Deviation	0.84685376	Variance	0.71716129
Skewness	-1.1794838	Kurtosis	1.68358105
Uncorrected SS	2113	Corrected SS	88.928
Coeff Variation	21.0450736	Std Error Mean	0.0757449

Basic Statistical Measures

Location		Variability	
Mean	4.024000	Std Deviation	0.84685
Median	4.000000	Variance	0.71716
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	53.12569	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.761036	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.344695	Pr > D	<0.0100
Cramer-von Mises	W-Sq	2.553055	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	12.83073	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V23

Moments

N	125	Sum Weights	125
Mean	3.616	Sum Observations	452
Std Deviation	1.02220508	Variance	1.04490323
Skewness	-0.1815431	Kurtosis	-1.0714438
Uncorrected SS	1764	Corrected SS	129.568
Coeff Variation	28.2689458	Std Error Mean	0.0914288

Basic Statistical Measures

Location		Variability	
Mean	3.616000	Std Deviation	1.02221
Median	4.000000	Variance	1.04490
Mode	4.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	39.5499	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---	-----p Value------

Shapiro-Wilk	W	0.872114	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.214415	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.917525	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.801869	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V24

Moments

N	125	Sum Weights	125
Mean	3.952	Sum Observations	494
Std Deviation	1.1560221	Variance	1.3363871
Skewness	-0.9555547	Kurtosis	-0.2439179
Uncorrected SS	2118	Corrected SS	165.712
Coeff Variation	29.2515714	Std Error Mean	0.10339776

Basic Statistical Measures

Location		Variability	
Mean	3.952000	Std Deviation	1.15602
Median	4.000000	Variance	1.33639
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.22133	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.786651	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.28456	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.79879	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	10.80245	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V25

Moments

N	125	Sum Weights	125
Mean	3.536	Sum Observations	442
Std Deviation	1.00437752	Variance	1.00877419
Skewness	-0.415694	Kurtosis	-0.6016031
Uncorrected SS	1688	Corrected SS	125.088
Coeff Variation	28.4043415	Std Error Mean	0.08983426

Basic Statistical Measures

Location		Variability	
Mean	3.536000	Std Deviation	1.00438
Median	4.000000	Variance	1.00877
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	39.36138	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.877291	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.269951	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.260292	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.82511	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V26

Moments

N	125	Sum Weights	125
Mean	2.72	Sum Observations	340
Std Deviation	0.81912621	Variance	0.67096774
Skewness	0.29274892	Kurtosis	-0.9854666
Uncorrected SS	1008	Corrected SS	83.2
Coeff Variation	30.1149341	Std Error Mean	0.07326488

Basic Statistical Measures

Location		Variability	
Mean	2.720000	Std Deviation	0.81913
Median	3.000000	Variance	0.67097
Mode	2.000000	Range	3.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	37.12557	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.824064	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.274295	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.564888	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.768783	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V27

Moments

N	125	Sum Weights	125
Mean	3.424	Sum Observations	428
Std Deviation	1.00212677	Variance	1.00425806
Skewness	-0.3007239	Kurtosis	-0.5623061
Uncorrected SS	1590	Corrected SS	124.528
Coeff Variation	29.2677211	Std Error Mean	0.08963294

Basic Statistical Measures

Location		Variability	
Mean	3.424000	Std Deviation	1.00213
Median	4.000000	Variance	1.00426
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.20024	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.8952	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.237279	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.04552	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.769463	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V28

Moments

N	125	Sum Weights	125
Mean	2.496	Sum Observations	312
Std Deviation	1.00501966	Variance	1.01006452
Skewness	0.71351587	Kurtosis	-0.0522592
Uncorrected SS	904	Corrected SS	125.248
Coeff Variation	40.2652107	Std Error Mean	0.08989169

Basic Statistical Measures

Location		Variability	
Mean	2.496000	Std Deviation	1.00502
Median	2.000000	Variance	1.01006
Mode	2.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	27.76675	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.85338	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.305178	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.694977	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	8.589259	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V29

Moments

N	125	Sum Weights	125
Mean	3.896	Sum Observations	487
Std Deviation	1.03817458	Variance	1.07780645
Skewness	-0.535862	Kurtosis	-0.8889492
Uncorrected SS	2031	Corrected SS	133.648
Coeff Variation	26.6471914	Std Error Mean	0.09285716

Basic Statistical Measures

Location		Variability	
Mean	3.896000	Std Deviation	1.03817
Median	4.000000	Variance	1.07781
Mode	5.000000	Range	3.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	41.95692	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.838421	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.219898	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.132983	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.378702	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V30

Moments

N	125	Sum Weights	125
Mean	3.576	Sum Observations	447
Std Deviation	1.04930084	Variance	1.10103226
Skewness	-0.4384597	Kurtosis	-0.5682836
Uncorrected SS	1735	Corrected SS	136.528
Coeff Variation	29.3428647	Std Error Mean	0.09385232

Basic Statistical Measures

Location		Variability	
Mean	3.576000	Std Deviation	1.04930
Median	4.000000	Variance	1.10103
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.10241	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.886629	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.248923	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.050416	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.841936	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V31

Moments

N	125	Sum Weights	125
Mean	3.08	Sum Observations	385
Std Deviation	1.04418513	Variance	1.09032258
Skewness	0.22667091	Kurtosis	-1.1036561
Uncorrected SS	1321	Corrected SS	135.2
Coeff Variation	33.9021145	Std Error Mean	0.09339476

Basic Statistical Measures

Location		Variability	
Mean	3.080000	Std Deviation	1.04419
Median	3.000000	Variance	1.09032
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	32.9783	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.863302	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.233502	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.168524	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.450033	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V32

Moments

N	125	Sum Weights	125
Mean	4.104	Sum Observations	513
Std Deviation	1.04591371	Variance	1.09393548
Skewness	-1.285494	Kurtosis	0.99192916
Uncorrected SS	2241	Corrected SS	135.648
Coeff Variation	25.4852268	Std Error Mean	0.09354937

Basic Statistical Measures

Location		Variability	
Mean	4.104000	Std Deviation	1.04591
Median	4.000000	Variance	1.09394
Mode	5.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	43.86989	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.761063	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.292397	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.964494	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	11.53222	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V33

Moments

N	125	Sum Weights	125
Mean	3.472	Sum Observations	434
Std Deviation	1.05933637	Variance	1.12219355
Skewness	-0.297714	Kurtosis	-0.7596564
Uncorrected SS	1646	Corrected SS	139.152
Coeff Variation	30.5108402	Std Error Mean	0.09474993

Basic Statistical Measures

Location		Variability	
Mean	3.472000	Std Deviation	1.05934
Median	4.000000	Variance	1.12219
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	36.64383	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.893404	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.234908	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.962268	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.526673	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V34

Moments

N	125	Sum Weights	125
Mean	3.928	Sum Observations	491
Std Deviation	0.90852592	Variance	0.82541935
Skewness	-0.9053973	Kurtosis	0.55312116

Uncorrected SS	2031	Corrected SS	102.352
Coeff Variation	23.1294787	Std Error Mean	0.08126103

Basic Statistical Measures

Location		Variability	
Mean	3.928000	Std Deviation	0.90853
Median	4.000000	Variance	0.82542
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	48.33805	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.816394	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.315583	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.929058	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.846543	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V35

Moments

N	125	Sum Weights	125
Mean	3.592	Sum Observations	449
Std Deviation	1.07084531	Variance	1.14670968
Skewness	-0.6038023	Kurtosis	-0.4355876
Uncorrected SS	1755	Corrected SS	142.192
Coeff Variation	29.8119518	Std Error Mean	0.09577932

Basic Statistical Measures

Location		Variability	
Mean	3.592000	Std Deviation	1.07085
Median	4.000000	Variance	1.14671
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	37.50288	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.865003	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.288401	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.402689	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.371267	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V36

Moments

N	125	Sum Weights	125
Mean	3.56	Sum Observations	445
Std Deviation	1.12450706	Variance	1.26451613
Skewness	-0.5497127	Kurtosis	-0.6266972
Uncorrected SS	1741	Corrected SS	156.8
Coeff Variation	31.587277	Std Error Mean	0.10057897

Basic Statistical Measures

Location		Variability	
Mean	3.560000	Std Deviation	1.12451
Median	4.000000	Variance	1.26452
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	35.39507	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.870218	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.276206	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.255911	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.82632	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V37

Moments

N	125	Sum Weights	125
Mean	3.424	Sum Observations	428
Std Deviation	0.95261948	Variance	0.90748387

Skewness	-0.7173196	Kurtosis	-0.4231588
Uncorrected SS	1578	Corrected SS	112.528
Coeff Variation	27.8218306	Std Error Mean	0.08520488

Basic Statistical Measures

Location		Variability	
Mean	3.424000	Std Deviation	0.95262
Median	4.000000	Variance	0.90748
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	40.18549	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.804047	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.343294	Pr > D	<0.0100
Cramer-von Mises	W-Sq	2.332461	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	12.39321	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V38

Moments

N	125	Sum Weights	125
Mean	3.656	Sum Observations	457
Std Deviation	1.00083836	Variance	1.00167742
Skewness	-0.635439	Kurtosis	-0.1204743
Uncorrected SS	1795	Corrected SS	124.208
Coeff Variation	27.3752286	Std Error Mean	0.0895177

Basic Statistical Measures

Location		Variability	
Mean	3.656000	Std Deviation	1.00084
Median	4.000000	Variance	1.00168
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	40.84108	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001

Signed Rank	S	3937.5	Pr >= |S|	<.0001	

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.868682	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.282468	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.383612	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.125224	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V39

Moments

N	125	Sum Weights	125
Mean	3.736	Sum Observations	467
Std Deviation	1.19234115	Variance	1.42167742
Skewness	-0.8078038	Kurtosis	-0.3341198
Uncorrected SS	1921	Corrected SS	176.288
Coeff Variation	31.914913	Std Error Mean	0.10664623

Basic Statistical Measures

Location		Variability	
Mean	3.736000	Std Deviation	1.19234
Median	4.000000	Variance	1.42168
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	35.03171	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.839404	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.283615	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.392123	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.824345	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V40

Moments

N	125	Sum Weights	125

Mean	3.44	Sum Observations	430
Std Deviation	1.19407138	Variance	1.42580645
Skewness	-0.3611541	Kurtosis	-1.0130278
Uncorrected SS	1656	Corrected SS	176.8
Coeff Variation	34.7113772	Std Error Mean	0.10680099

Basic Statistical Measures

Location		Variability	
Mean	3.440000	Std Deviation	1.19407
Median	4.000000	Variance	1.42581
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	32.20944	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.875203	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.256459	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.116971	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.449925	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V41

Moments

N	125	Sum Weights	125
Mean	2.696	Sum Observations	337
Std Deviation	1.04127713	Variance	1.08425806
Skewness	0.33485167	Kurtosis	-0.6945815
Uncorrected SS	1043	Corrected SS	134.448
Coeff Variation	38.623039	Std Error Mean	0.09313466

Basic Statistical Measures

Location		Variability	
Mean	2.696000	Std Deviation	1.04128
Median	2.000000	Variance	1.08426
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test -Statistic- -----p Value------

Student's t	t	28.94733	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.887942	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.252064	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.136437	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.374833	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V42

Moments

N	125	Sum Weights	125
Mean	3.192	Sum Observations	399
Std Deviation	1.11221952	Variance	1.23703226
Skewness	-0.1741675	Kurtosis	-0.8041358
Uncorrected SS	1427	Corrected SS	153.392
Coeff Variation	34.8439699	Std Error Mean	0.09947994

Basic Statistical Measures

Location		Variability	
Mean	3.192000	Std Deviation	1.11222
Median	3.000000	Variance	1.23703
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	32.08687	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.908177	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.206226	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.822925	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	4.759008	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V43

Moments

N	125	Sum Weights	125
Mean	3.648	Sum Observations	456
Std Deviation	0.98583516	Variance	0.97187097
Skewness	-0.6782274	Kurtosis	-0.2345221
Uncorrected SS	1784	Corrected SS	120.512
Coeff Variation	27.0239902	Std Error Mean	0.08817578

Basic Statistical Measures

Location		Variability	
Mean	3.648000	Std Deviation	0.98584
Median	4.000000	Variance	0.97187
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	41.37191	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.84011	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.319476	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.860094	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.405583	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V44

Moments

N	125	Sum Weights	125
Mean	2.952	Sum Observations	369
Std Deviation	1.07655364	Variance	1.15896774
Skewness	0.13602594	Kurtosis	-0.7172413
Uncorrected SS	1233	Corrected SS	143.712
Coeff Variation	36.4686193	Std Error Mean	0.09628988

Basic Statistical Measures

Location		Variability	
Mean	2.952000	Std Deviation	1.07655
Median	3.000000	Variance	1.15897
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

NOTE: The mode displayed is the smallest of 2 modes with a count of 38.

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.65743	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.910188	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.187734	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.82875	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	4.771967	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V45

Moments

N	125	Sum Weights	125
Mean	3.28	Sum Observations	410
Std Deviation	0.95545969	Variance	0.91290323
Skewness	-0.4776209	Kurtosis	-0.0888279
Uncorrected SS	1458	Corrected SS	113.2
Coeff Variation	29.1298687	Std Error Mean	0.08545891

Basic Statistical Measures

Location		Variability	
Mean	3.280000	Std Deviation	0.95546
Median	3.000000	Variance	0.91290
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.38102	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.884232	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.230444	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.204801	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.557718	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V46

Moments

N	125	Sum Weights	125
Mean	2.736	Sum Observations	342
Std Deviation	1.00918364	Variance	1.01845161
Skewness	0.31353558	Kurtosis	-0.7963598
Uncorrected SS	1062	Corrected SS	126.288
Coeff Variation	36.8853668	Std Error Mean	0.09026413

Basic Statistical Measures

Location		Variability	
Mean	2.736000	Std Deviation	1.00918
Median	3.000000	Variance	1.01845
Mode	2.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.31104	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.874534	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.263092	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.279095	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.386822	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V47

Moments

N	125	Sum Weights	125
Mean	3.072	Sum Observations	384
Std Deviation	1.13005852	Variance	1.27703226
Skewness	-0.0752521	Kurtosis	-1.1333925
Uncorrected SS	1338	Corrected SS	158.352
Coeff Variation	36.7857591	Std Error Mean	0.10107551

Basic Statistical Measures

Location		Variability	
Mean	3.072000	Std Deviation	1.13006
Median	3.000000	Variance	1.27703
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	30.39312	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.87647	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.242233	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.225051	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.169179	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V48

Moments

N	125	Sum Weights	125
Mean	2.872	Sum Observations	359
Std Deviation	0.88878315	Variance	0.78993548
Skewness	-0.0247976	Kurtosis	-0.2355573
Uncorrected SS	1129	Corrected SS	97.952
Coeff Variation	30.9464884	Std Error Mean	0.07949518

Basic Statistical Measures

Location		Variability	
Mean	2.872000	Std Deviation	0.88878
Median	3.000000	Variance	0.78994
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	36.12798	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.891979	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.229257	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.243562	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.503013	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V49

Moments

N	125	Sum Weights	125
Mean	2.92	Sum Observations	365
Std Deviation	0.7577556	Variance	0.57419355
Skewness	-0.0913184	Kurtosis	-0.1033572
Uncorrected SS	1137	Corrected SS	71.2
Coeff Variation	25.9505342	Std Error Mean	0.06777572

Basic Statistical Measures

Location		Variability	
Mean	2.920000	Std Deviation	0.75776
Median	3.000000	Variance	0.57419
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	43.08327	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.854323	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.27004	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.777064	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.101283	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V50

Moments

N	125	Sum Weights	125
Mean	2.904	Sum Observations	363
Std Deviation	1.1029579	Variance	1.21651613
Skewness	0.11944285	Kurtosis	-0.9740145
Uncorrected SS	1205	Corrected SS	150.848
Coeff Variation	37.9806439	Std Error Mean	0.09865155

Basic Statistical Measures

Location		Variability	
Mean	2.904000	Std Deviation	1.10296
Median	3.000000	Variance	1.21652
Mode	2.000000	Range	4.00000

Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	29.43694	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.893224	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.225782	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.008428	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.959638	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V51

Moments

N	125	Sum Weights	125
Mean	3.104	Sum Observations	388
Std Deviation	0.96573555	Variance	0.93264516
Skewness	-0.1021196	Kurtosis	-0.7954481
Uncorrected SS	1320	Corrected SS	115.648
Coeff Variation	31.1126145	Std Error Mean	0.08637801

Basic Statistical Measures

Location		Variability	
Mean	3.104000	Std Deviation	0.96574
Median	3.000000	Variance	0.93265
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	35.93507	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.887022	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.215242	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.066867	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.506977	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V52

Moments

N	124	Sum Weights	124
Mean	3.16935484	Sum Observations	393
Std Deviation	1.02585894	Variance	1.05238657
Skewness	-0.1635525	Kurtosis	-0.8154438
Uncorrected SS	1375	Corrected SS	129.443548
Coeff Variation	32.3680685	Std Error Mean	0.09212485

Basic Statistical Measures

Location		Variability	
Mean	3.169355	Std Deviation	1.02586
Median	3.000000	Variance	1.05239
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	34.40282	Pr > |t|	<.0001
Sign	M	62	Pr >= |M|	<.0001
Signed Rank	S	3875	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.892961	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.22643	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.01919	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.03561	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V53

Moments

N	125	Sum Weights	125
Mean	2.576	Sum Observations	322
Std Deviation	1.04158688	Variance	1.08490323
Skewness	0.53414131	Kurtosis	-0.307037
Uncorrected SS	964	Corrected SS	134.528
Coeff Variation	40.4342732	Std Error Mean	0.09316236

Basic Statistical Measures

Location		Variability	
Mean	2.576000	Std Deviation	1.04159
Median	2.000000	Variance	1.08490

Mode	2.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	27.65065	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.88398	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.261869	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.207375	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.390791	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V54

Moments

N	125	Sum Weights	125
Mean	3.32	Sum Observations	415
Std Deviation	0.98864521	Variance	0.97741935
Skewness	-0.5805272	Kurtosis	-0.2933813
Uncorrected SS	1499	Corrected SS	121.2
Coeff Variation	29.7784702	Std Error Mean	0.08842712

Basic Statistical Measures

Location		Variability	
Mean	3.320000	Std Deviation	0.98865
Median	4.000000	Variance	0.97742
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	37.54504	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.866571	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.274214	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.413143	Pr > W-Sq	<0.0050

Anderson-Darling	A-Sq	7.739898	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V55

Moments

N	125	Sum Weights	125
Mean	3.424	Sum Observations	428
Std Deviation	0.9940468	Variance	0.98812903
Skewness	-0.7374543	Kurtosis	-0.2418814
Uncorrected SS	1588	Corrected SS	122.528
Coeff Variation	29.0317405	Std Error Mean	0.08891025

Basic Statistical Measures

Location		Variability	
Mean	3.424000	Std Deviation	0.99405
Median	4.000000	Variance	0.98813
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.51075	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.827678	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.326857	Pr > D	<0.0100
Cramer-von Mises	W-Sq	2.0393	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	10.59708	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V56

Moments

N	125	Sum Weights	125
Mean	2.68	Sum Observations	335
Std Deviation	1.00482706	Variance	1.00967742
Skewness	0.34160671	Kurtosis	-0.4345268
Uncorrected SS	1023	Corrected SS	125.2
Coeff Variation	37.493547	Std Error Mean	0.08987446

Basic Statistical Measures

Location Variability

Mean	2.680000	Std Deviation	1.00483
Median	3.000000	Variance	1.00968
Mode	2.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	29.81937	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.897273	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.230712	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.048158	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.746022	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V57

Moments

N	125	Sum Weights	125
Mean	3.632	Sum Observations	454
Std Deviation	1.05138925	Variance	1.10541935
Skewness	-0.6941886	Kurtosis	-0.0578368
Uncorrected SS	1786	Corrected SS	137.072
Coeff Variation	28.9479419	Std Error Mean	0.09403911

Basic Statistical Measures

Location		Variability	
Mean	3.632000	Std Deviation	1.05139
Median	4.000000	Variance	1.10542
Mode	4.000000	Range	5.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	38.62223	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.848326	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.324836	Pr > D	<0.0100

Cramer-von Mises	W-Sq	1.939278	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.518412	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V58

Moments

N	125	Sum Weights	125
Mean	2.784	Sum Observations	348
Std Deviation	0.90325576	Variance	0.81587097
Skewness	-0.0910094	Kurtosis	-0.3357441
Uncorrected SS	1070	Corrected SS	101.168
Coeff Variation	32.4445316	Std Error Mean	0.08078965

Basic Statistical Measures

Location		Variability	
Mean	2.784000	Std Deviation	0.90326
Median	3.000000	Variance	0.81587
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	34.45986	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.892283	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.2345	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.207227	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	6.341084	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V59

Moments

N	125	Sum Weights	125
Mean	3.256	Sum Observations	407
Std Deviation	1.1209443	Variance	1.25651613
Skewness	-0.1382405	Kurtosis	-0.9159753
Uncorrected SS	1481	Corrected SS	155.808
Coeff Variation	34.4270363	Std Error Mean	0.10026031

Basic Statistical Measures

Location		Variability	
Mean	3.256000	Std Deviation	1.12094
Median	3.000000	Variance	1.25652
Mode	4.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	32.47546	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.902981	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.210567	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.84054	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	4.99001	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V60

Moments

N	125	Sum Weights	125
Mean	3.096	Sum Observations	387
Std Deviation	0.995344	Variance	0.99070968
Skewness	-0.1952368	Kurtosis	-0.5366888
Uncorrected SS	1321	Corrected SS	122.848
Coeff Variation	32.149354	Std Error Mean	0.08902627

Basic Statistical Measures

Location		Variability	
Mean	3.096000	Std Deviation	0.99534
Median	3.000000	Variance	0.99071
Mode	3.000000	Range	4.00000
		Interquartile Range	2.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	34.77625	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test --Statistic--- -----p Value------

Shapiro-Wilk	W	0.902734	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.194121	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.9671	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.47568	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V61

Moments

N	125	Sum Weights	125
Mean	2.248	Sum Observations	281
Std Deviation	0.86747688	Variance	0.75251613
Skewness	0.54825829	Kurtosis	0.49503603
Uncorrected SS	725	Corrected SS	93.312
Coeff Variation	38.588829	Std Error Mean	0.07758949

Basic Statistical Measures

Location		Variability	
Mean	2.248000	Std Deviation	0.86748
Median	2.000000	Variance	0.75252
Mode	2.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	28.973	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.863703	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.260518	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.419442	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.36276	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V62

Moments

N	125	Sum Weights	125
Mean	3.176	Sum Observations	397
Std Deviation	0.97603543	Variance	0.95264516
Skewness	-0.1503103	Kurtosis	-0.46312
Uncorrected SS	1379	Corrected SS	118.128
Coeff Variation	30.7315942	Std Error Mean	0.08729926

Basic Statistical Measures

Location		Variability	
Mean	3.176000	Std Deviation	0.97604
Median	3.000000	Variance	0.95265
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	36.38061	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.903772	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.19273	Pr > D	<0.0100
Cramer-von Mises	W-Sq	0.992183	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	5.481532	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure
Variable: V63

Moments

N	125	Sum Weights	125
Mean	3.336	Sum Observations	417
Std Deviation	0.94990662	Variance	0.90232258
Skewness	-0.6647829	Kurtosis	-0.2248391
Uncorrected SS	1503	Corrected SS	111.888
Coeff Variation	28.474419	Std Error Mean	0.08496223

Basic Statistical Measures

Location		Variability	
Mean	3.336000	Std Deviation	0.94991
Median	4.000000	Variance	0.90232
Mode	4.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	39.26451	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---	-----p Value------

Shapiro-Wilk	W	0.845875	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.293729	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.652054	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	9.108139	Pr > A-Sq	<0.0050

The UNIVARIATE Procedure

Variable: V64

Moments

N	125	Sum Weights	125
Mean	2.656	Sum Observations	332
Std Deviation	0.86232993	Variance	0.7436129
Skewness	0.19487234	Kurtosis	-0.1233184
Uncorrected SS	974	Corrected SS	92.208
Coeff Variation	32.4672412	Std Error Mean	0.07712913

Basic Statistical Measures

Location		Variability	
Mean	2.656000	Std Deviation	0.86233
Median	3.000000	Variance	0.74361
Mode	3.000000	Range	4.00000
		Interquartile Range	1.00000

Tests for Location: Mu0=0

Test	-Statistic-		-----p Value------	
Student's t	t	34.43576	Pr > |t|	<.0001
Sign	M	62.5	Pr >= |M|	<.0001
Signed Rank	S	3937.5	Pr >= |S|	<.0001

Tests for Normality

Test	--Statistic---		-----p Value------	
Shapiro-Wilk	W	0.883587	Pr < W	<0.0001
Kolmogorov-Smirnov	D	0.216591	Pr > D	<0.0100
Cramer-von Mises	W-Sq	1.32266	Pr > W-Sq	<0.0050
Anderson-Darling	A-Sq	7.020586	Pr > A-Sq	<0.0050

REFERENCE LIST

1. Anderson D (1999) 'Expanding environmental risk management' [online] (cited 25 July 2003) Available from <URL:http://firstsearch.sabinet.co.za>

2. Aupperle, KE, Carroll, AB, Hatfield, JD (1985) 'An Empirical Examination of the Relationships between Corporate Social Responsibility and Profitability', *Academy of Management Journal,* 28:2, 446 - 463

3. Banerjee SB and Iyer (2003) 'Corporate Environmentalism: Antecedents and Influence of Industry Type' [online] (cited 25 July 2003) Available from <URL:http://firstsearch.sabinet.co.za>

4. Beaumont, JR, Pederson, LM and Whitaker, BD (1993) *Managing the Environment,* Butterworth-Heinemann Limited. United States of America.

5. Benham A and Benham L (2001) 'The Costs of Exchange' [online] (cited 26 September 2003) Available from <URL:http://coase.org/research.htm>

6. Bennett, SJ Freierman, R and George, S (1993) *Corporate Realities and Environmental Truths*, John Wiley and Sons Incorporated, Toronto.

7. Bentler (1989); cited by Hatcher, L (1994) *A Step-by-Step Approach to Using SAS for Factor Analysis and Structural Equation Modeling,* SAS Institute Inc., North Carolina

8. Botha, Z (2003) 'Sustainability a core business value', *Engineering News,* March 2003, p.71

9. Byrne, BM (1994) *Structural Equation Modeling with EQS and EQS/Windows,* Sage Publication Inc, California.

10. Coase R (1998) 'The New Institutional Economics' [online] (cited 26 September 2003) Available from <URL:http://coase.org/research.htm>

11. Coase R (1988); cited by Wang N (2003) 'Measuring Transaction Costs: An Incomplete Survey' [online] (cited 26 September 2003) Available from <URL:http://coase.org/research.htm>

12. Colby B (1990); cited by Wang (2003) *ibid.*

13. Coomber (1997); cited by Saunders, M, Lewis, P and Thornhill, A (2003) *Research Methods for Business Students* (3rd edn), Rotolito Lombarda, Italy

14. Cronbach, LJ (1951) 'Coefficient Alpha and the Internal Structure of Tests', *Psychometrika*, 16:3, 297 - 334

15. Dechant, K and Altman, B (1994) 'Environmental leadership: From compliance to competitive advantage', *Academy of Management Executive*, 8:3, 7 – 27

16. Department of Environmental Affairs and Tourism (2003) 'Guernica Chemicals' [online] (cited 5 June 2003) Available from <URL: http://www.environment.gov.za/NewsMedia/MedS.../guernica_chemicals_12032003.html>

17. Department of Environmental Affairs and Tourism (2003) 'Polifin Plant's Registration Certificate' withdrawn' [online] (cited 23 September 2003) Available from <URL:http://www.environment.gov.za/newsmedia/medstat/2000sept15/15sept2000.htm>

18. Department of Minerals and Energy (2002) 'Digest of South African Energy Statistics' [online] (cited 17 March 2004) Available from <URL:http://www.dme.gov.za/energy/energy_efficiency.htm>

19. Department of Trade and Industry (2003) 'The Need for a South African EG&S Forum – First Draft Discussion Document'. 12 May 2003. Pretoria.

20. Department of Trade and Industry (2003) ‘SA Economy’ [online] (cited 3 March 2004) Available from <URL:http://www.dti.gov.za/saeconomy/sectors.htm>

21. Elkington (2002); cited by Scott F (2002) ‘Sustainable business makes dollars & sense’ [online] (cited 2 June 2003) Available from <URL:http://firstsearch.sabinet.co.za>

22. Elmore and Beggs (1975); cited by Sekaran, U (1992) *Research Methods for Business* (2nd edn), John Wiley & Sons Inc., Canada

23. Ernst & Young (2003) ‘Sustainability reporting mirrors role of business’ [online] (cited 7 April 2003) Available from <URL:http://m1.mny.co.za/cfacc.nsf/UNID/SKEP-5KTDVA?OpenDocument>

24. Faeth P (2002); cited by Fields S (2002) ‘Sustainable business makes dollars & sense’ [online] (cited 2 June 2003) Available from <URL:http//firstsearch.sabinet.co.za>

25. Fields S (2002) ‘Sustainable business makes dollars & sense’ [online] (cited 2 June 2003) Available from <URL:http//firstsearch.sabinet.co.za>

26. Forbes S (2003) ‘Environmental Compliance and Management Benefits’ [online] (cited 11 February 2003) Available from <URL:http://www.trst.com>

27. Freeman, RE (1984); cited by Banerjee and Iyer (2003) *op.cit.*

28. Friedrich, E (2003) ‘The Environmental Life Cycle Assessment As A Holistic Environmental Tool – Part One’, *Chemical Technology*, January 2003

29. Garrent, DE (1987); cited by Schiffman, LG and Kanuk, LL (1991) *Consumer Behaviour* (4th edn), Prentice-Hall International Inc., United States of America

30. Glasnapp, DR and Poggio, JP (1985) *Essentials of Statistical Analysis for the Behavioural Sciences,* Charles E. Merrill Publishing Company, Ohio

31. Harrison J (2000) ‘Acquiring the socially conscious company’ [online] (cited 25 July 2003) Available from <URL:http//firstsearch.sabinet.co.za>

32. Hart, SL (1997) ‘Beyond Greening: Strategies for a Sustainable World’, *Harvard Business Review,* 75:1, 67 – 76

33. Hatcher, L (1994) *A Step-by-Step Approach to Using SAS for Factor Analysis and Structural Equation Modeling,* SAS Institute Inc., North Carolina

34. Henderson, PGW (1994) 'Fiscal Incentives for Environmental Protection – Introduction', *The South African Journal of Law*, vol.1 p.49 – 60.

35. International Chamber of Commerce (1990); cited by North, K (1997) *Environmental Business Management* 2nd (revised) edition, International Labour Office, Geneva**.**

36. Johannesburg World Summit 2002 (2002) [online] (cited 23 September 2003) Available from <URL:http://www.joburgsummit.co.za>

37. Klassen, RD and McLaughlin, CP (1996) 'The Impact of Environmental Management on Firm Performance', *Management Science*, 42:8, 1199 – 1214

38. Kim, JO and Mueller, CW (1978) *Introduction to Factor Analysis What It Is and How To Do It*, Sage Publications Ltd., California.

39. Letsoalo, M (2003) 'Warning of jobs bloodbath' *Mail&Guardian*, p.3

40. Loots C (1994) 'Making Environmental Law Effective', *The South African Journal of Law*, vol.1, p. 17 – 34.

41. McCann, Easter, L and Easter, KW (1997); cited by Wang (2003) *op.cit.*

42. Mohr, P and Fourie, L (2000) *Economics for South African Student,*(7th edn), J.L. van Schaik Publishers, Pretoria.

43. Naidoo S (2002) 'Sustainability reporting becomes mainstream' [online] (cited 23 September 2003) Available from <URL:http://www.kpmg.co.za/modules/library/>

44. Naidoo S (2004) 'Manuel's pollution taxes aim to clean up industry', *Business Day*, January 2004

45. Naldi GJ (2000) 'The Regulation of the Transnational Trade in Hazardouse Wastes – The African Response', *South African Law Journal,* vol.7, p.213 – 237.

46. Newton-King N (2003); cited by Botha Z (2003) *op.cit*.

47. North, K (1997) *Environmental Business Management* (2nd edn), International Labour Office, Geneva.

48. Nunnally, JC and Bernstein, IH (1994) *Psychometric Theory* (3rd edn), McGraw-Hill Inc., United States of America.

49. Oberthür, S (1999) ‘Linkages between the Montreal and Kyoto Protocols’ [online] (cited 23 September 2003) Available from <URL:http://www.unep.org/ozone/montreal/Montreal_Kyoto_Protocol.htm>

50. Olver, C (2003); cited by Paton, C (2003) ‘Hover Through The Fog’, *Financial Mail,* 25 July 2003, p.42 – 43

51. Parket, R and Eilbirt, H (1975); cited by Aupperle *et al.* (1985) *op.cit*.

52. Patel, Z and Peart, R (1998) ‘Decision making by firms in South Africa on the adoption of cleaner technologies: A case study of the chemical, food and textile industries’, Council for Science and Industry Research.

53. Piasecki, BW, Fletcher, KA and Mendelson, FJ (1999) *Environmental Management and Business Strategy – Leadership Skills for the 21st Century*, John Wiley & Sons, United States of America.

54. Porter, ME and Van der Linde, C (1995a) ‘Green and Competitive: Ending the Stalemate’, *Harvard Business Review,* 73:5, p. 120 – 133.

55. Porter, ME and Van der Linde, C (1995b) ‘Toward a New Conception of the Environment- Competitiveness Relationship’, *Journal of Economic Perspectives*, 9:4, p. 97 –118

56. Quick MBA Strategic Management (2003) ‘Competitive Advantage’ [online] (cited 23 September 2003) Available from <URL:http://www.quickmba.com/strategy/competitive-advantage/>

57. Quick MBA Strategic Management (2003) ‘Porter’s Five Forces – A model for industry analysis’ [online] (cited 23 September 2003) Available from <URL:http://www.quickmba.com/strategy/porter.shtml>

58. Rawicz, M (1994) ‘Holistic Environmental Management’ *a paper presented at the First Conference on Environmental Management, Technology and Development.* 7-8 March. Johannesburg.

59. Reinhardt, FL (1999) ‘Bringing the environment down to earth’, *Harvard Business Review*, 77, p.149 – 157

60. Report of the United Nations Conference on Environment and Development (1992) ‘Rio Declaration on Environment and Development’ [online] cited 5 June 2003 Available from <URL:http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>

61. Republic of South Africa, Department of Water Affairs and Forestry. 2001. Waste Management Series. Minimum Requirements for Waste Disposal, Hazardous Waste Management and Monitoring (Second Edition, 1998). Pretoria.

62. Robson (1993); cited by Saunders M, Lewis P, Thornhill A (2003) Research Methods for Business Students 3rd ed. Rotolito Lombarda, Italy.

63. Russo, MV and Fouts, PA (1997) 'A Resource-based perspective on corporate environmental performance and profitability', *Academy of Management Journal*, 40:3, p. 534 – 559

64. SABC News (2003) 'More job losses due to plastic bags legislation' [online] (cited 10 October 2003) Available from <URL:http://www.sabcnews.com/economy/labour/0,2172,62648,00.html>

65. SABC News (2003) 'Cape PLC' [online] (cited 11 June 2003) Available from <URL: http://www.sabcnews.com/Article/print_whole_story/0,1093,55015,00.html>

66. Sarkis J (1995) 'Greening the manufacturing function' [online] (cited 25 July 2003) Available from <URL:http//firstsearch.sabinet.co.za>

67. Saunders, M, Lewis, P and Thornhill, A (2003) *Research Methods for Business Students* (3rd edn), Rotolito Lombarda, Italy

68. Schiffman, LG and Kanuk, LL (1991) *Consumer Behaviour* (4th edn), Prentice-Hall International Inc., United States of America

69. Secretariat of the Basel Convention – Introduction (2003) [online] (cited 23 September 2003) Available from <URL:http://www.basel.int/pub/basics.html>

70. Sekaran, U (1992) *Research Methods for Business* (2nd edn), John Wiley & Sons Inc., Canada

71. Shreiner B (2002) 'The National Research and Technology Foresight Study: South African Foresight Environmental Report' [online] (cited 4 March 2003) Available from <URL:http//www.dst.gov.za>.

72. Shrivastava, P (1995) 'Environmental technologies and competitive advantage', *Strategic Management Journal*, 16, p. 183 – 200

73. Simmons, IG (1981) *The Ecology of Natural Resources* (2nd edn), Edward Arnold (Publishers) Limited,

74. Skivington, P (1994) 'Economic and Financial Implications' *paper presented at the First Conference on Environmental Management, Technology and Development*

75. South African Government (2003) 'Legislation by subject' [online] (cited 23 September 2003) Available from <URL:http://www.gov.za/documents/03sublist.htm>

76. South African Government (2003) '2002 Legislation' [online] (cited 23 September 2003) Available from <URL:http://www.gov.za/gazette/acts/02index.html>

77. South African Law Reports 'Minister of Health and Welfare vs. Woodcarb (Pty.) Ltd. And Another '1996 (3) SA 155 (N)

78. South African Law Reports 'Minister of Health and Welfare vs. Drums and Pails Reconditioning cc t/a Village Drums and Pails' 1997 (3) SA 867

79. Structural Equation Modeling (2002) [online] (cited 28 February 2003) Available from <URL:http://www2.chass.ncsu.edu/garson/pa765/structur.htm>

80. Stewart, TA (2001) *The Wealth of Knowledge – Intellectual Capital and the Twenty-first Century Organization,* Doubleday, United States of America

81. Sunter, C (1997) *What is really takes to be world class*, Human & Rousseau Tafelberg, Cape Town.

82. The Economist (1994); cited by Russo and Fouts (1996) *op.cit.*

83. The Montreal Protocol On Substances that deplete the Ozone Layer (2003) [online] (cited 23 September 2003) Available from <URL:http://www.unep.org/ozone/montreal.shtml>

84. Tladi D (2000) 'The Liability Protocol to the Basel Convention on Transboundary Movement of Hazardous Wastes: an overview', *South African Law Journal*, vol. 7, p.203 – 212

85. United Nations Division for Sustainable Development Agenda 21 Chapter 30 (2003) [online] (cited 5 June 2003) Available from <URL:http//www.un.org/esa/sustdev/documents/agenda21chapter30.htm>

86. United Nations Division for Sustainable Development WSSD Plan of Implementation (2003) [online] (cited 5 June 2003) Available from <URL:http//www.un.org/esa/sustdev/documents/>

87. Van Niekerk B (1976) 'Environmental pollution – the new international crime', *South African Journal of Law,* vol. 93, p. 69 – 80

88. Visser W (1998) 'SA environmental mindset needs to shift' [online] (cited 23 September 2003) Available from <URL:http://www.kpmg.co.za/modules/library/detail.cfm>

89. Visser W (2000) 'Sinking roots into ethical ground of business' [online] (cited 23 September 2003) Available from <URL:http://www.sundaytimes.co.za/2000/06/18/business/columns.htm>

90. Wang N (2003) 'Measuring Transaction Costs: An Incomplete Survey' [online] (cited 26th September 2003) Available from URL:http://coase.org/research.htm>

BIBLIOGRAPHY

1. Department of Environmental Affairs (2004) 'How Industry Drives Environmental Change in South Africa' [online] (cited 12 January 2004) Available from <URL:http://www.environment.gov.za>

2. Department of Environmental Affairs (2004) 'First ever pollution arrest conducted in East London' [online] (cited 12 January 2004) Available from <URL:http://www.environment.gov.za/NewsMedia/MedStat/2004Jan12/pollution Arrest_1201.htm>

3. Eskeland, GS and Harrison, AE (1997) 'Moving to Greener Pastures? Multinationals and the Pollution Haven Hypothesis' [online] (cited 11 December 2003) Available from <URL:http://econ.worldbank.org/docs/1525.pdf>

4. Greenpeace International (2002) 'Corporate Crimes: The need for an international instrument on corporate accountability and liability' [online] (cited 11 December

2003) Available from
<URL:http://www.greenpeace.org/multimedia/download/1/15643/0/corporatecrimes_entire.pdf>

5. Kaynak, H (2003) 'The relationship between total quality management practices and their effects on firm performance', *Journal of Operations Management,* 21, 405-435

6. Möhr-Swart, M (2003) 'Environmental Management Accounting Seminar' 23 May 2003. Pretoria.

7. Sethi, V and King, R (1994) 'Development of Measures to Assess the Extent to Which an Information Technology Application Provides Competitive Advantage', *Management Science,* 40:12, 1601-1627
8. Wilson, JS, Otsuki, T and Sewadeh, M (2002) 'Dirty Exports and Environmental Regulation: Do Standards Matter to Trade?' [online] (cited 11 December 2003) Available from URL:http://econ.worldbank.org/files/13167_wps2806.pdf

9. World Economic Forum and World Bank Institute (2003) 'Overall competitiveness rankings' [online] (cited 11 December 2003) Available from URL:http://www.weforum.org/pdf/gcr/GCR_2002_2003/GCR_Rankings_2002_2003.pdf