



# MONASH University

## Study report

# Carbon trading, performance measurement systems, innovation, and performance

**Do not reproduce or cite without written consent from the study's authors.**

Dr Aldónio Ferreira

Dr Carly Moulang

March 2009

## FINDINGS REPORT

### 1. Introduction

We are pleased to present our preliminary findings on the research project entitled, 'Carbon trading, performance measurement systems, innovation, and performance'. This study examines the relationship between the use of environment-related information in decision making, and innovation and performance. In particular, this study investigates how the presence of environmental performance measurement systems leads to enhanced product and process innovations within organisations and ultimately to performance.

We thank you for participating and providing valuable information which makes this important study possible. We received 149 *usable* responses to our online survey of members of CPA Australia.<sup>1</sup> As a consequence we have made a donation to Greenfleet, on behalf of the participants, to offset the CO<sub>2</sub> emissions equivalent of driving cars for 149,000 km (149 x 1000 km).<sup>2</sup>

This report displays the primary analysis which is mostly descriptive in nature. While further analysis will be carried out to examine the relationship between different variables, the descriptive analysis provides information on the nature, pattern and shape of the key variables. We have, nevertheless, included a preliminary multivariate analysis for your benefit. We have included the main variables, such as, product innovation, R&D commitments, environmental performance measurement systems (EPMS) use, and performance. These variables were generally measured on a 1-7 point Likert scales. In addition to these key variables, this report also shows relevant demographic information on respondents and organisational characteristics.

We hope you will enjoy this report and if you require further information please contact us.

---

<sup>1</sup> The total number of participants in our online survey was 216, but about 5 of these have not completed essential questions to this study, thus rendering them unusable for the multivariate analysis.

<sup>2</sup> A copy of Greenfleet's Carbon Offsetting certificate is provided in Appendix. In total, \$1080 was donated for carbon offsets. The Certification includes the carbon offset for the 149 responses received in the online survey plus 211 responses for a paper version of the same survey, totalling 360 responses.

## 2. The results

### 2.1. Univariate analysis

#### *Performance*

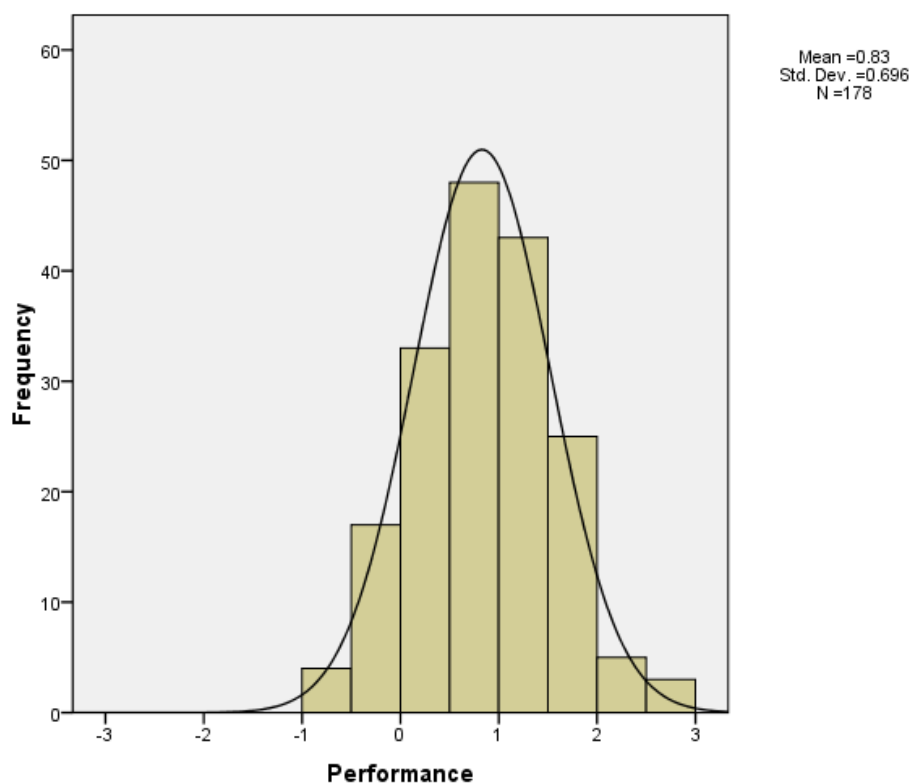
Table 1 shows different dimensions of organisations' performance. The scale used to measure performance ranged from *well below competitors* (-3) to *well above competitors* (+3). The overall performance item was obtained by weighing the performance scores by the importance scores of each dimension (as noted by the participants in a separate question).

**Table 1: Performance - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Short-term financial performance	178	-3	3	.75	1.296
Customer-relations performance	178	-3	3	1.25	1.178
Employee-relations performance	178	-3	3	.92	1.152
Operational performance	178	-3	3	.82	1.095
Quality performance	178	-1	3	1.10	1.018
Alliances performance	178	-3	3	.20	1.145
Supplier-relations performance	178	-3	3	.51	0.958
Environmental performance	178	-3	3	.48	1.096
Innovation performance	178	-3	3	.62	1.276
Community-relations performance	178	-3	3	.44	1.139
<b>Performance (overall)</b>	<b>178</b>	<b>-0.69</b>	<b>2.75</b>	<b>.83</b>	<b>.696</b>

The results show an overall mean of 0.83 with a standard deviation of 0.696. The distribution shows a normal symmetric pattern and has a higher level of performance, measured in various aspects. These figures suggest that organisations studied as a whole exhibit an overall performance above the average. Only few organisations report an overall underperformance, but none of them at a level extremely low (the minimum is -0.69). Similarly, not many companies 'sit' at the high end of the scale.

## FINDINGS REPORT: Carbon trading, performance measurement systems, innovation, and performance



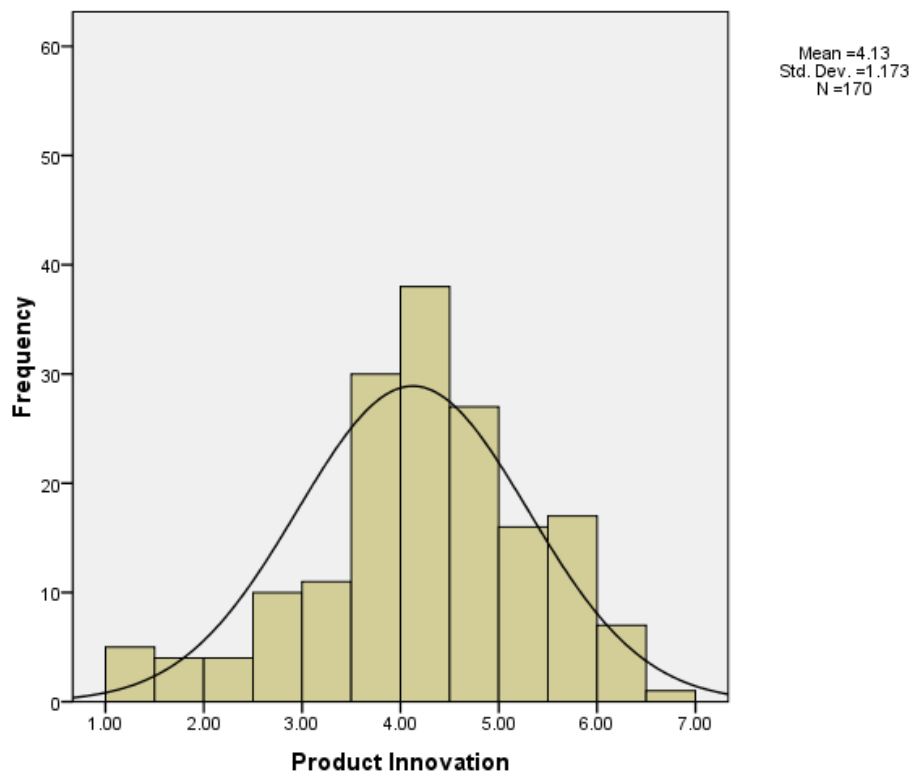
### *Product Innovation*

Product innovation is a measure of the extent to which companies has been successful in the introduction of new products or services in their chosen markets. It is a relative measure in that this is assessed in relation to the ‘industry average’, thus enabling its comparison across sectors.

**Table 2: Product Innovation - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
My company has launched many new products/services	170	1	7	4.16	1.728
My company has launched many modifications to already existing products/services	170	1	7	4.52	1.524
My company is very often the first-to-market new products/services	167	1	7	4.06	1.627
The percentage of new products/services in my company's product portfolio is much higher than the	169	1	7	4.02	1.558
Our new products/services are minor improvements in a current technology	169	1	7	4.03	1.274
Our new products/services incorporate a large new body of technological knowledge	169	1	7	3.93	1.678
<b>Product Innovation</b>	<b>170</b>	<b>1</b>	<b>6.5</b>	<b>4.13</b>	<b>1.173</b>

The results in Table 2 show that, on average, the organisations displayed a moderate level of product innovation with a mean of 4.13 (standard deviation of 1.173) and a distribution approximately normal. The findings also show that a considerable proportion of organisations studied exhibited a very low level of product innovation (i.e. below 3). There is a good spread among studied companies, ranging from low level to high levels of product innovation. This is consistent with our expectations.



### *Process Innovation*

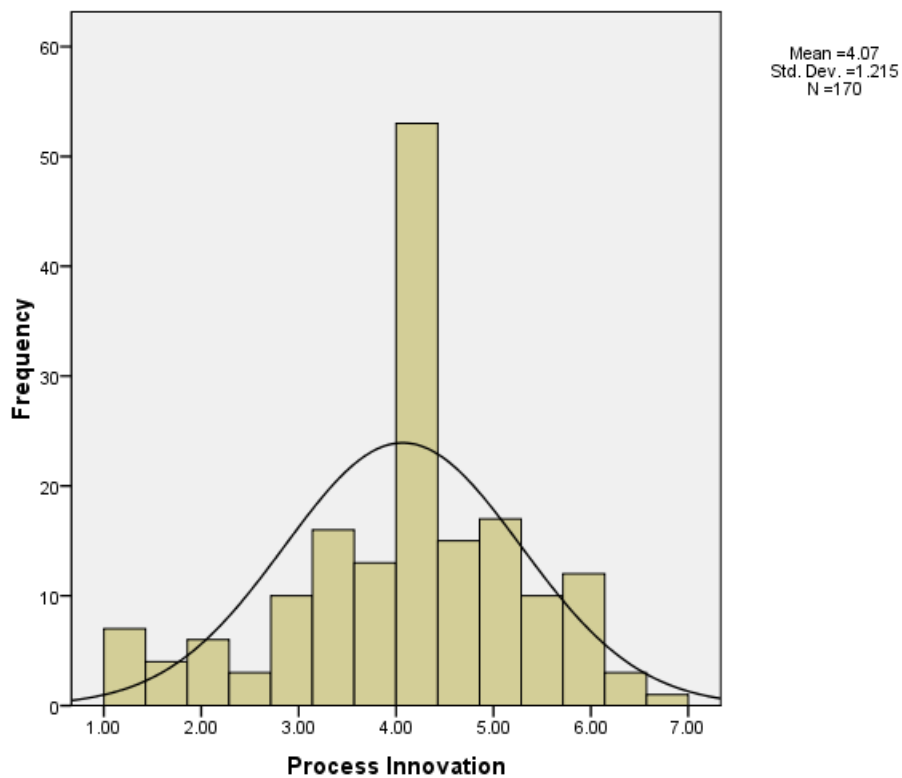
Product innovation is a measure of the extent to which companies has been successful in the innovating in processes related to production of products or delivery of services. It is also a relative measure — assessed against the ‘industry average’ — which enables its comparison across industries.

The degree of process innovation in firms was measured by using five items and the results show that, on average, the organisations studied are moderately innovative with respect to processes (mean of 4.07 and standard deviation of 1.215). The distribution of the process innovation variable shows an approximately normal

pattern, although clearly peaked in the middle ground. Compared to product innovation, the findings suggest that there is a greater number of organisations displaying a low level of innovation in relation to production/services processes.

**Table 3: Process Innovation - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
My company has introduced many new production/service processes	167	1	7	4.04	1.460
My company has introduced many modifications to production/service processes	170	1	7	4.26	1.391
My company is very often the first to introduce new production/service processes	169	1	7	3.92	1.414
The frequency of production/service process improvements in my company is much higher than the industry average	170	1	7	4.04	1.327
The degree of innovativeness of my company's technology is much higher than the industry average	170	1	7	4.1	1.413
<b>Process Innovation</b>	<b>170</b>	<b>1</b>	<b>6.6</b>	<b>4.07</b>	<b>1.215</b>

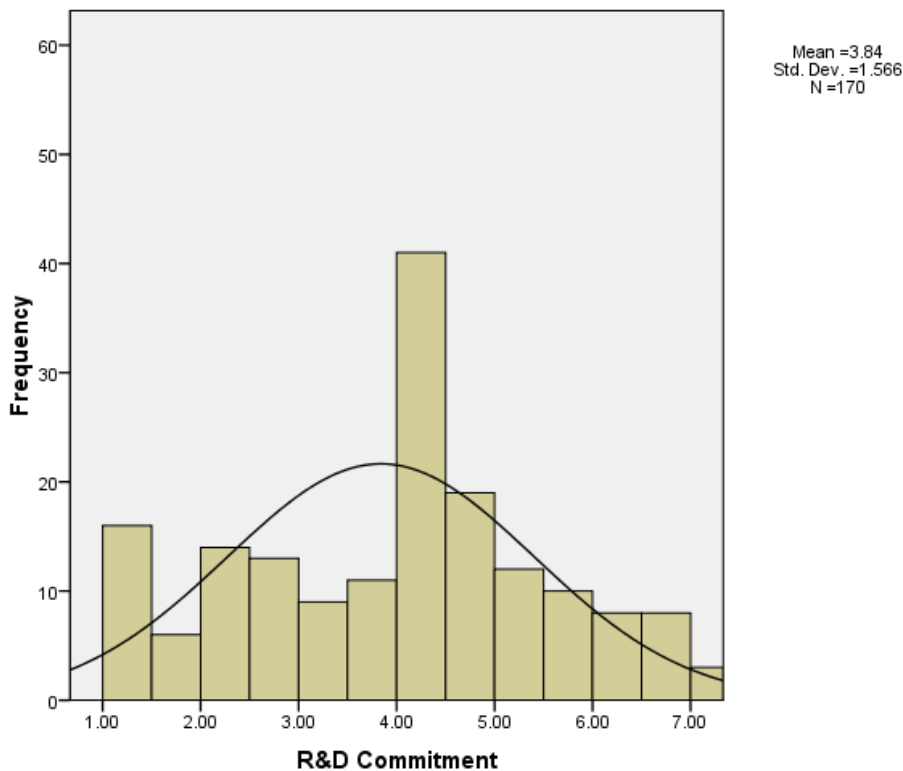


**R&D Commitment**

Innovation is an outcome to which many factors contribute. One of the key determinants is the organisation’s commitment to R&D, which is has been measured in this study with four items. These capture the amount of resources invested and the emphasis placed in R&D. Hence, R&D commitment is an input measure when compared to product or process innovation (output measures).

**Table 4: R&D Commitment - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
My company commits more resources to R&D than the industry average	170	1	7	3.78	1.548
My company places a strong emphasis on R&D, technological leadership, and innovation	170	1	7	4.14	1.775
My company is serious about investment in R&D	170	1	7	4.02	1.762
My company is a R&D intensive organisation in its industry	170	1	7	3.42	1.736
<b>R&amp;D Commitment</b>	<b>170</b>	<b>1</b>	<b>7</b>	<b>3.84</b>	<b>1.566</b>



The results show that the organisations have moderate to low commitment to R&D investment, with a mean of 3.84 and a standard deviation of 1.566. The distribution is slightly negatively skewed with more concentration in the high end and with a long

tail of distribution at the lower end of the distribution. The findings show a range of degrees of R&D Commitment among the studied organisations. There is a considerable number of organisations with extremely low level of R&D Commitment and, implicitly, R&D investment.

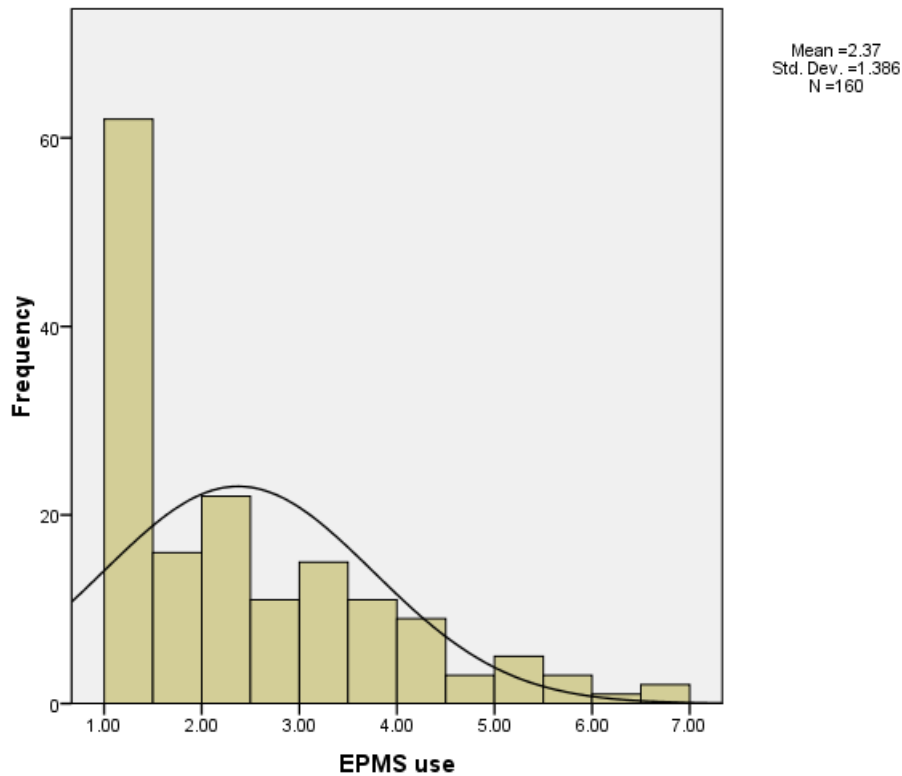
### *EPMS Use*

This variable consisted of fifteen items aimed to reflect the extent to which environmental performance measurement activities were carried out by the studied companies (these are distinct from other general performance measurement activities). It used a 7-point Likert scale with three anchors: “Has not done at all”, “Has done to some extent”, and “Has done to a great extent”.

**Table 5: EPMS Use - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Identification of environmental costs borne by your company	160	1	7	3.23	1.880
Identification of environmental costs borne by the community	160	1	7	2.34	1.652
Estimation of environmental contingent liabilities (e.g. EPA fines)	160	1	7	2.38	1.715
Classification of environmental costs	160	1	7	2.53	1.808
Allocation of environmental costs to production processes	159	1	7	2.18	1.675
Allocation of environmental costs to products	160	1	7	2.26	1.767
Engaging in environmental cost management activities	159	1	7	2.92	1.926
Creation and/or use of environmental cost accounts	159	1	7	1.89	1.421
Development and/or refinement of environmental key performance indicators (KPIs)	159	1	7	2.28	1.797
Use of environmental key performance indicators (KPIs) in performance evaluations	160	1	7	2.08	1.660
Introduction of environmental impact assessments in capital investment appraisals	160	1	7	2.41	1.796
Preparation of product life-cycle cost assessments	160	1	7	2.18	1.545
Benchmarking of your environmental performance against best practice	160	1	7	2.26	1.750
Integration of environmental strategies with the overall business strategy	158	1	7	2.84	1.870
Integration of the environmental management accounting system into business management systems	159	1	7	1.84	1.408
<b>EPMS use</b>	<b>160</b>	<b>1</b>	<b>6.8</b>	<b>2.37</b>	<b>1.386</b>

The results in Table 5 show that the studied organisations display a low level of EPMS Use, with a mean of 2.37 (standard deviation of 1.386). The distribution is positively and extremely skewed, providing evidence that environmental performance measurement systems have extremely low levels of implementation across the majority of the companies studied.



### *Entrepreneurial Strategy*

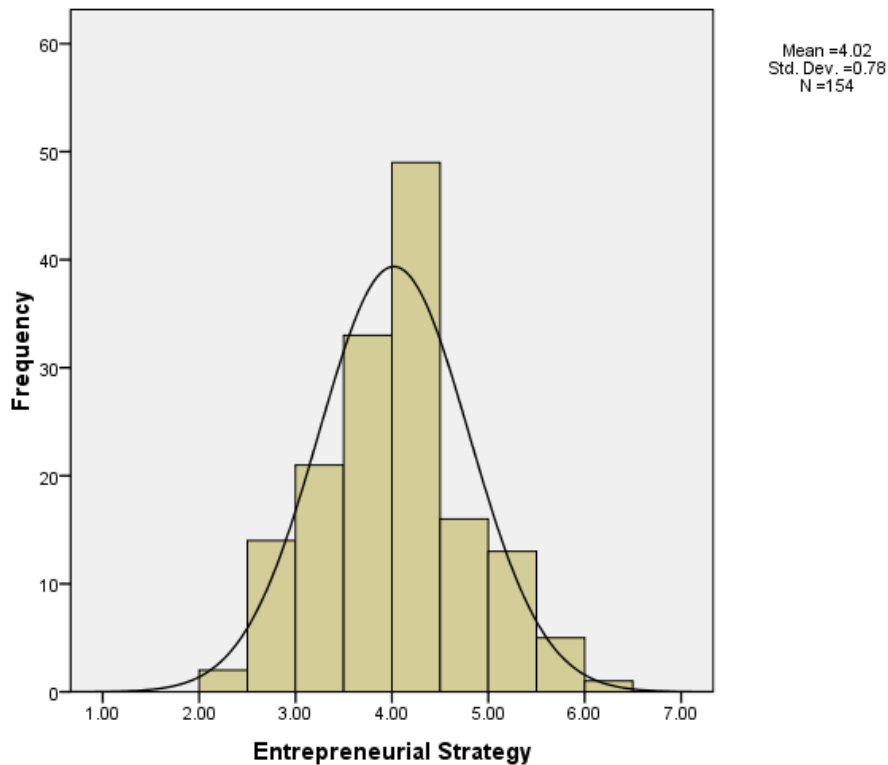
Entrepreneurial strategy, which contrasts with conservative strategy, is a measure of the proclivity of the organisation to embrace change through innovation. In the past, conservative strategies used to be more predominant because innovation and change were not traditional state of affairs for organisations. Entrepreneurial strategy was measured using the nine items identified in Table 6 below.

Respondents have rated entrepreneurial strategy at a moderate level, with a mean of 4.02 (standard deviation of 0.780). The distribution of entrepreneurial strategy shows a relatively normal distribution, although with a small tail at the high end. This suggests that entrepreneurial strategies are far more common than they used to be, although there is still a predominance of conservative strategies.

**Table 6: Entrepreneurial Strategy - Descriptive Statistics**

Descriptive Statistics					
	N	Min	Max	Mean	Std. Dev.
The top managers of my company favour a strong emphasis on the marketing of tried-and-true products or services (#)	154	1	7	4.64	1.362
My company has marketed new lines of products or services in the past 3 years	154	1	7	4.97	1.662
My company made mostly minor changes in product or service lines in the past 3 years (#)	154	1	7	4.11	1.444
My company typically responds to actions which competitors initiate (#)	153	1	7	3.63	1.499
My company is very seldom the first business to introduce new products/services, administrative techniques, operating technologies, etc. (#)	154	1	7	3.62	1.669
My company typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture (#)	153	1	7	3.42	1.524
The top managers of my company have a strong natural inclination for low risk projects (with normal and certain rates of return) (#)	154	1	7	3.97	1.606
The top managers of my company believe that owing to the nature of the environment, it is best to explore gradually via cautious, incremental behaviour (#)	152	1	7	4.01	1.391
My company typically adopts a cautious, "wait and see" posture when confronted with decision-making situations involving uncertainty, in order to minimize the probability of making costly decisions (#)	154	1	7	3.80	1.448
<b>Entrepreneurial Strategy</b>	<b>154</b>	<b>2.22</b>	<b>6.11</b>	<b>4.0198</b>	<b>.78023</b>

(#) These items are reverse coded in relation to entrepreneurial strategy.



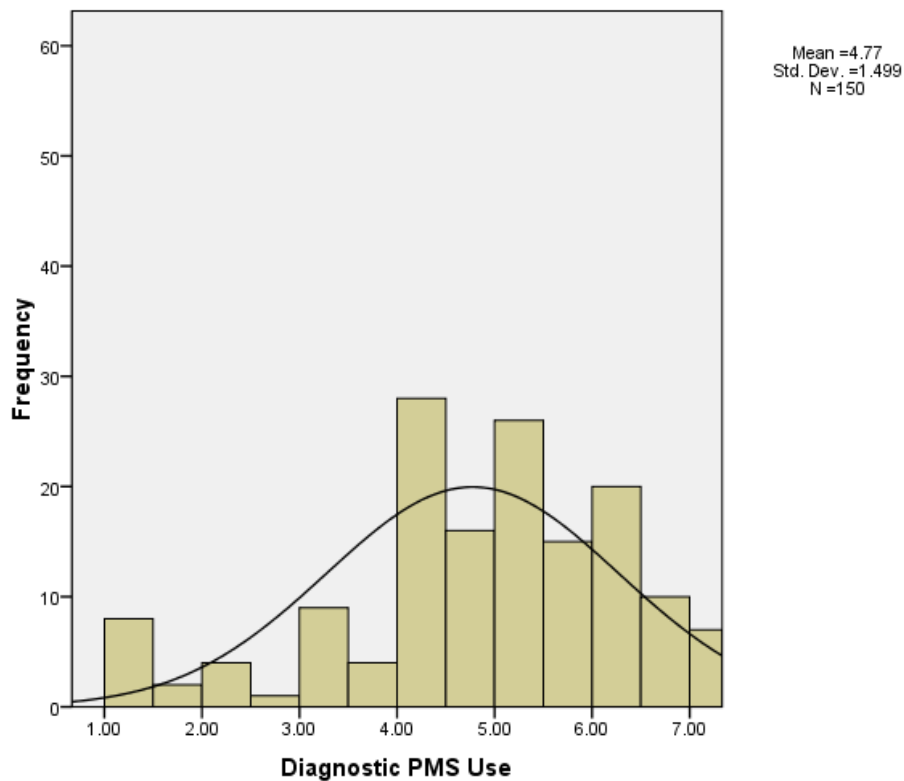
*Diagnostic PMS Use*

Diagnostic PMS use is a formal, traditional, mechanistic ways of examining the performance of the organisation involving formal measurement and feedback procedures. Diagnostic use is necessary in all organisations to track the achievement of organisational objectives, but an overly excessive focus has been shown to be detrimental as it increases the level of dysfunctional behaviours among organisational members. This concept was measured by seven items.

**Table 7: Diagnostic PMS Use - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
The PMS enables the company to focus on critical success factors	150	1	7	4.68	1.564
The PMS is used to track progress towards pre-established goals	150	1	7	4.86	1.614
The PMS is used to monitor the company's results	150	1	7	4.95	1.596
The PMS is used to compare outcomes to expectations	149	1	7	4.98	1.613
The PMS is used to review key performance indicators	149	1	7	4.91	1.678
The PMS is used to plan how operations are to be conducted in accordance with the strategic plan	146	1	7	4.52	1.649
Top managers use the PMS to review performance and follow up on exceptions	149	1	7	4.57	1.612
<b>Diagnostic PMS Use</b>	<b>150</b>	<b>1.00</b>	<b>7.00</b>	<b>4.77</b>	<b>1.499</b>

The results show a moderate to high level of diagnostic PMS use, with a 4.77 mean (standard deviation of 1.50). This level of use is in line with our expectations. The distribution of the variable exhibits a slightly negatively skewed tendency. However, the findings show a range of degrees of diagnostic PMS use among the studied organisations with two aspects emerging. On one hand, there are a number of organisations with an extremely low level of diagnostic PMS use, which is somewhat concerning as this could endanger the very existence of those organisations. A minimum level of diagnostic PMS use is required for survival in most organisations. On the other hand, there is a significant proportion of organisations that exhibit a very high level of diagnostic use, which could risk the internal levels of trust and reduce its flexibility to respond to changes in the environment.



### *Interactive PMS Use*

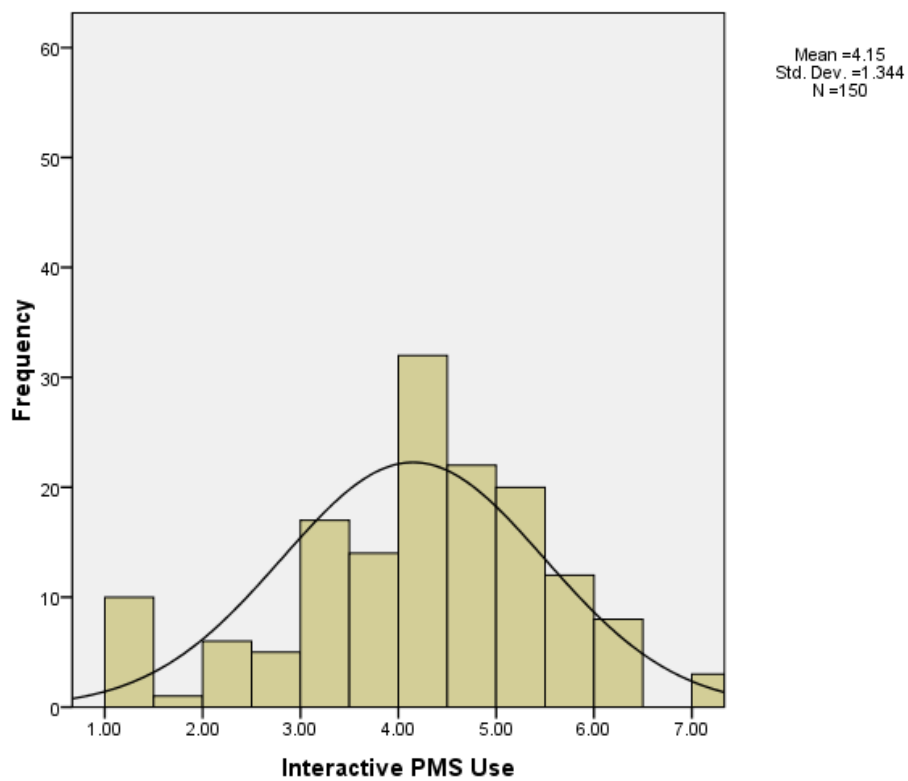
The level of interactive use of performance measurement systems was measured by five items, as outlined in Table 8. It is important to understand how organisations use their formal control systems to achieve organisational objectives. The different styles of use of PMS can assist managers to solve problems in different ways and has been shown by research to be as important as the technical/architectural aspects of control systems design. An interactive use of management control systems enables strategic dialogue between employees in different hierarchical positions within organisations, empowers employees, and releases the creative and innovative ways of thinking and resolving problems. Hence, interactive use represents a flexible way of coping with environmental uncertainty.

The results show that the organisations exhibited a moderate level of interactive use of performance management systems with a mean of 4.15 (standard deviation of 1.344) and a distribution approximately normal. This suggests that the organisations could potentially enhance their performance by increasing the extent of interactive use of

their performance management systems, particular in companies with an extreme low level of interactive use of their performance management systems.

**Table 8: Interactive PMS Use - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
There is intensive use of the PMS by top managers	150	1	7	4.49	1.710
There is intensive use of the PMS by operational managers	150	1	7	4.39	1.613
The PMS focuses on the strategic uncertainties facing the company	149	1	7	3.74	1.507
Top managers have a non-invasive, facilitating and inspirational involvement with regards to the PMS	149	1	7	3.93	1.441
The PMS is used regularly and frequently in face-to-face meetings between operational and top managers	150	1	7	4.17	1.661
<b>Interactive PMS Use</b>	<b>150</b>	<b>1.00</b>	<b>7.00</b>	<b>4.15</b>	<b>1.344</b>



### *Beliefs Systems*

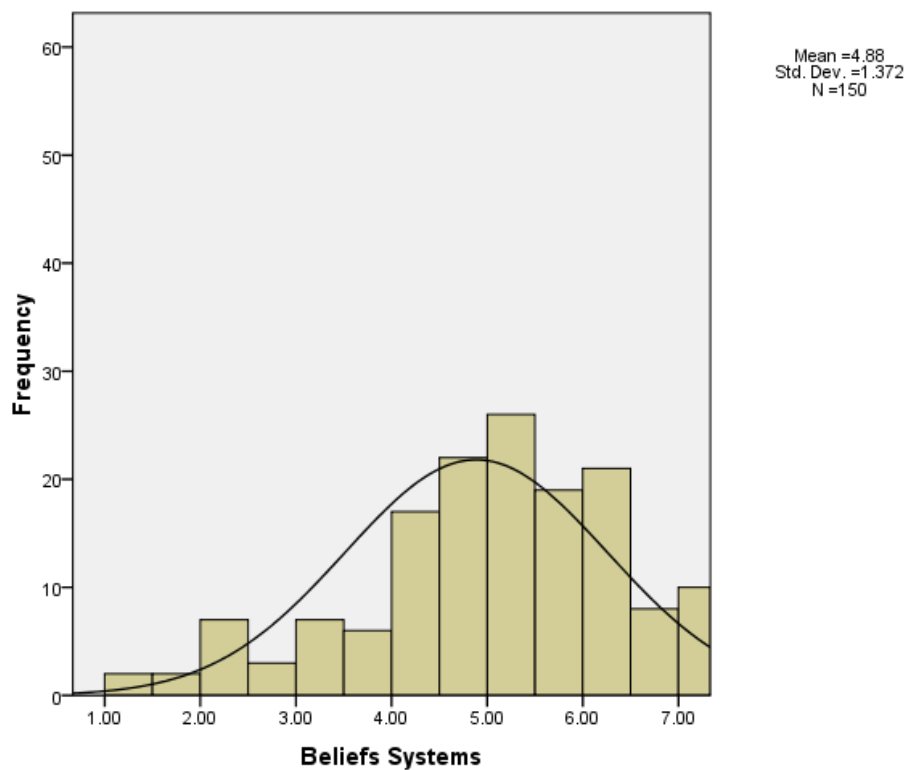
Beliefs systems are used to control the organisations' core values and they guide the creative process of exploring new opportunities and instil widely shared beliefs. They

are important in setting the long term direction of the company. Beliefs systems were measured by using the four items outlined in Table 9.

**Table 9: Beliefs Systems - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Our mission statement clearly communicates the company's core values to our workforce	150	1	7	5.11	1.697
Top managers communicate core values to our workforce	150	1	7	5.21	1.382
Our workforce is aware of the company's core values	150	1	7	4.99	1.565
Our mission statement inspires our workforce	150	1	7	4.23	1.614
<b>Beliefs Systems</b>	<b>150</b>	<b>1.00</b>	<b>7.00</b>	<b>4.89</b>	<b>1.372</b>

The results show that the organisations have a moderate to high level of beliefs system instilled into their companies (mean of 4.89 and standard deviation of 1.372). The distribution is partially skewed with larger concentration on the high end of the scale and a long tail at the lower end. This suggests that majority of the companies investigated have a clear and strong beliefs system in place.

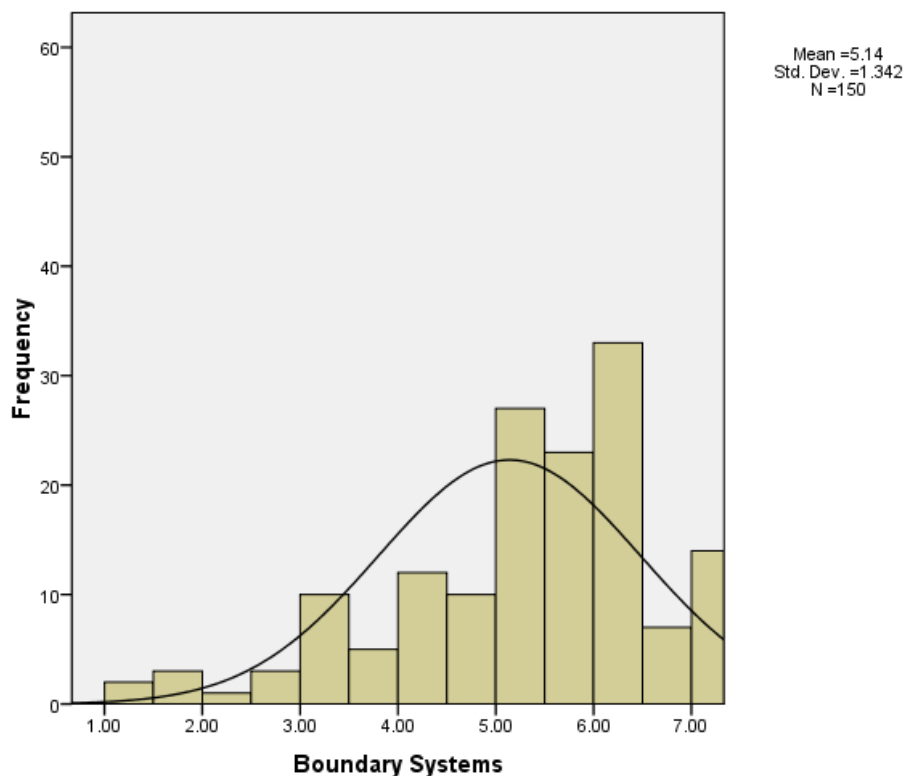


*Boundary Systems*

Boundary systems represent a negative force in the control system and they are used to control the risks to be avoided, by circumscribing the domain where the company seeks new opportunities. They are important in defining the boundaries and curbing excessive creativity and innovation. Boundary systems were measured by using the four items outlined in Table 9.

**Table 10: Boundary Systems - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Our company relies on a code of business conduct to define appropriate behaviour for our workforce	150	1	7	5.14	1.488
Our code of business conduct informs our workforce about behaviours that are off-limits	150	1	7	5.16	1.589
Our company has a system that communicates to our workforce risks that should be avoided	150	1	7	5.23	1.405
Our workforce is aware of the company's code of business conduct	150	1	7	5.03	1.569
<b>Boundary Systems</b>	<b>150</b>	<b>1.00</b>	<b>7.00</b>	<b>5.14</b>	<b>1.342</b>



Respondents have rated the level of boundary systems within their organisations as being high, with a mean of 5.14 and a standard deviation of 1.342. Similar to the

distribution of the beliefs system, the nature of distribution of the boundary system is also negatively skewed with more concentration in the high end with a long tail of distribution at the low end of the distribution. However, the level of the boundary systems is slightly higher than the beliefs systems which suggest that the companies studied place a stronger emphasis in the establishing of boundary systems than they do in promoting core values and beliefs.

### *Environmental Awareness*

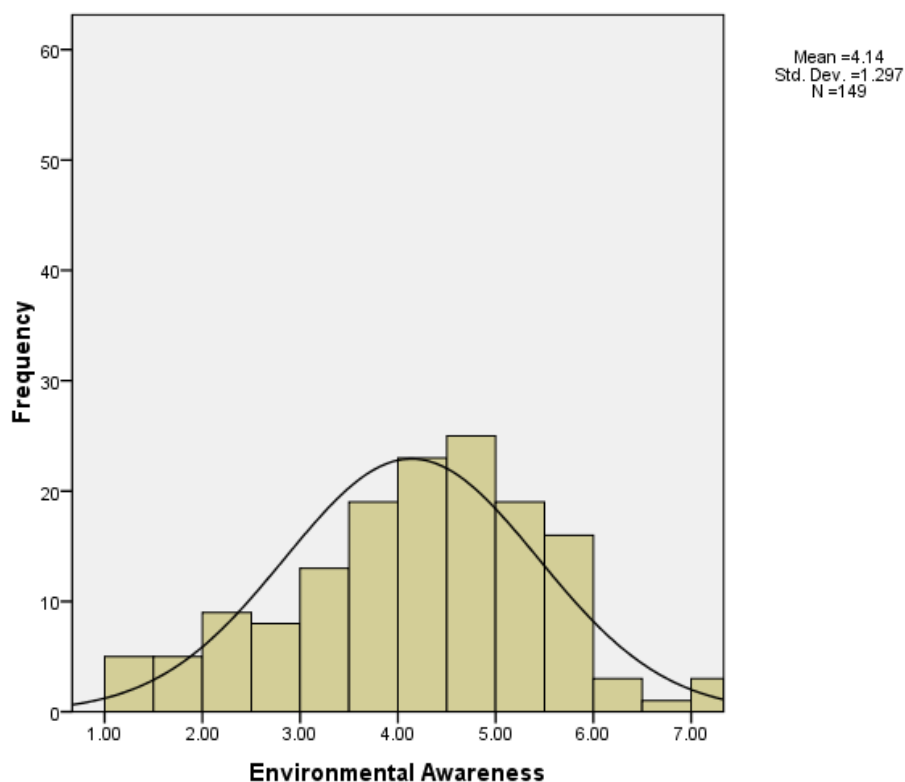
Environmental Awareness is a measure of the extent to which companies expect to be affected by changes and pressures deriving from their institutional environments and stakeholders as a consequence of environmental concerns (e.g. climate change). The variable comprised eight items, ranging from changes in customer preferences to the introduction of a carbon trading scheme.

**Table 11: Environmental Awareness - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Changes in customer preferences	149	1	7	4.21	1.915
Changes in government regulations	149	1	7	4.93	1.744
Changes in the nature of competition	149	1	7	4.34	1.727
Changes in the availability of natural resources	148	1	7	4.53	1.839
Pressure from employees to change business practices	149	1	7	3.64	1.534
Pressure from shareholders to change business practices	149	1	7	3.76	1.944
Pressure from suppliers to change business practices	149	1	7	3.37	1.698
The introduction of a carbon trading scheme	148	1	7	4.36	1.903
<b>Environmental Awareness</b>	<b>149</b>	<b>1.00</b>	<b>7.00</b>	<b>4.14</b>	<b>1.297</b>

Table 11 shows that respondents rated environmental awareness at a moderate level, with a mean of 4.14 and standard deviation of 1.297. The variable appears to be normally distributed. However, the results also suggest that a significant proportion of the companies studied had very low level of environmental awareness (i.e. below 3). The key areas of concern identified by participants were related to changes in government regulations and the introduction of a carbon trading scheme, while pressures from their supply chain (i.e. pressure from suppliers to change business practices) was the least concerning.

FINDINGS REPORT: Carbon trading, performance measurement systems, innovation, and performance



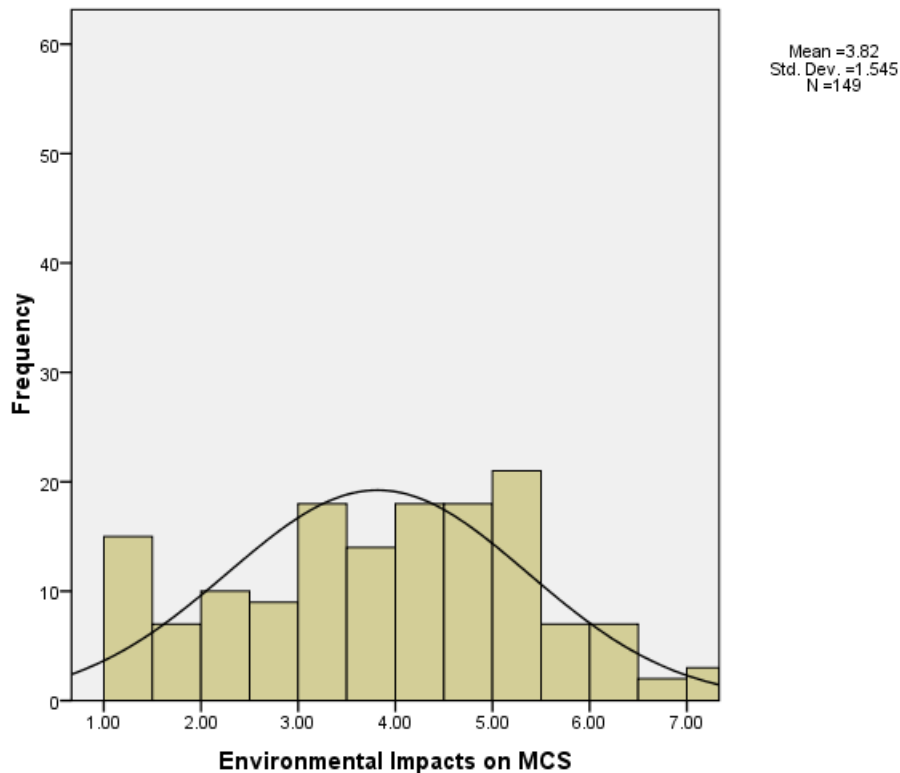
*Environmental Impacts on PMS*

Participants were asked to indicate the extent to which they expected the internal systems of their companies to be affected by the introduction of a carbon trading scheme. This included nine sub-systems that form part of the broader performance measurement and control system.

**Table 12: Environmental Impact on PMS - Descriptive Statistics**

	N	Min	Max	Mean	Std. Dev.
Performance measurement systems	149	1	7	3.95	1.886
Costing systems	149	1	7	4.27	1.975
Financial reporting systems	149	1	7	4.30	1.906
Senior management compensation systems	148	1	7	3.16	1.840
Employee compensation systems	148	1	7	2.97	1.740
Transfer pricing systems	149	1	7	2.99	1.805
Capital investment appraisal systems	147	1	7	4.08	1.878
Strategic management systems	149	1	7	4.19	1.800
Risk management systems	149	1	7	4.46	1.761
<b>Environmental Impacts on PMS</b>	<b>149</b>	<b>1.00</b>	<b>7.00</b>	<b>3.82</b>	<b>1.545</b>

With a mean of 3.82 (standard deviation of 1.545), the findings show that the impact on internal PMS is expected to be moderate to low. At the lower end of the spectrum, we have changes to employee compensation systems and to transfer pricing systems, while at the high end we find changes to risk management systems, to financial reporting systems, and to costing systems.



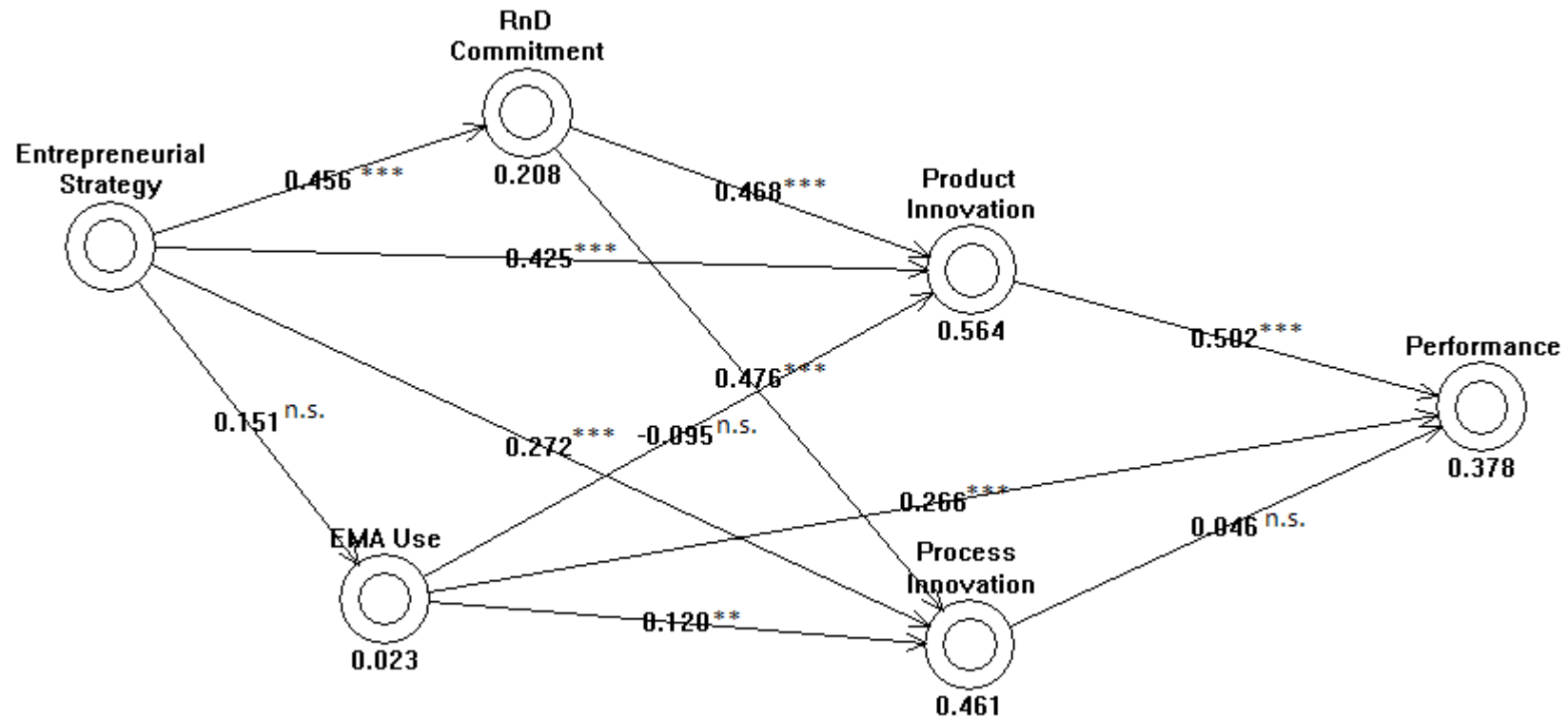
The distribution of environmental impacts on MCS is slightly positively skewed with a long tail of distribution at the higher end of the distribution. This is a consistent pattern when compared to environmental awareness (both distributions are approximately normal). However, the distribution of environmental impacts on PMS is more spread and positively skewed as compared to environmental awareness. This suggests that companies are well aware of the environmental issues relevant to their firms; however, the anticipated impacts on PMS are not large.

## 2.2. *Multivariate analysis (preliminary analysis)*

The analysis of the variables measured as well as the relationships between them is to be considered at the multivariate level of analysis. This analysis is work in progress, although some preliminary results are already available, as shown over the next page. Some of the **preliminary findings** are as follows:

- Higher performing firms exhibit higher levels of both product innovation and the use of environmental performance measurement systems (EPMS), with the effect of innovation being twice as strong as that of EPMS Use.
- Process innovation has no significant effect on performance.
- The use of EPMS has a positive effect on process innovation. The effect on product innovation was found not significant, a finding that is surprising as this frequently argued as one of the benefits of EPMS Use.
- As expected, R&D commitment shows a very strong relationship with both forms of innovation.
- Entrepreneurial strategy has a very strong positive association with R&D Commitment and with both product and process innovation. This was expected. Further analysis (not reported) indicates no significant relationship between entrepreneurial strategy and performance, suggesting that both entrepreneurial and conservative strategies are associated with performance.

## The framework of the study (preliminary findings)



**Notes:** (1) The coefficients under the variables (circles) indicate the proportion explained by the variables considered (e.g. 20.8% of the variance in R&D Commitment is explained by entrepreneurial strategy).

(2) The coefficients on the arrows are standardised coefficients which enables direct comparison between them. The significance level of the coefficients (two-tailed test) were calculated using bootstrapping are noted with stars as follows \*\*\* for  $p < 0.01$ ; \*\* for  $p < 0.05$ , \* for  $p < 0.1$ .

### 3. Demographic information of study participants

Figure 1: Distribution of responses per activity sector

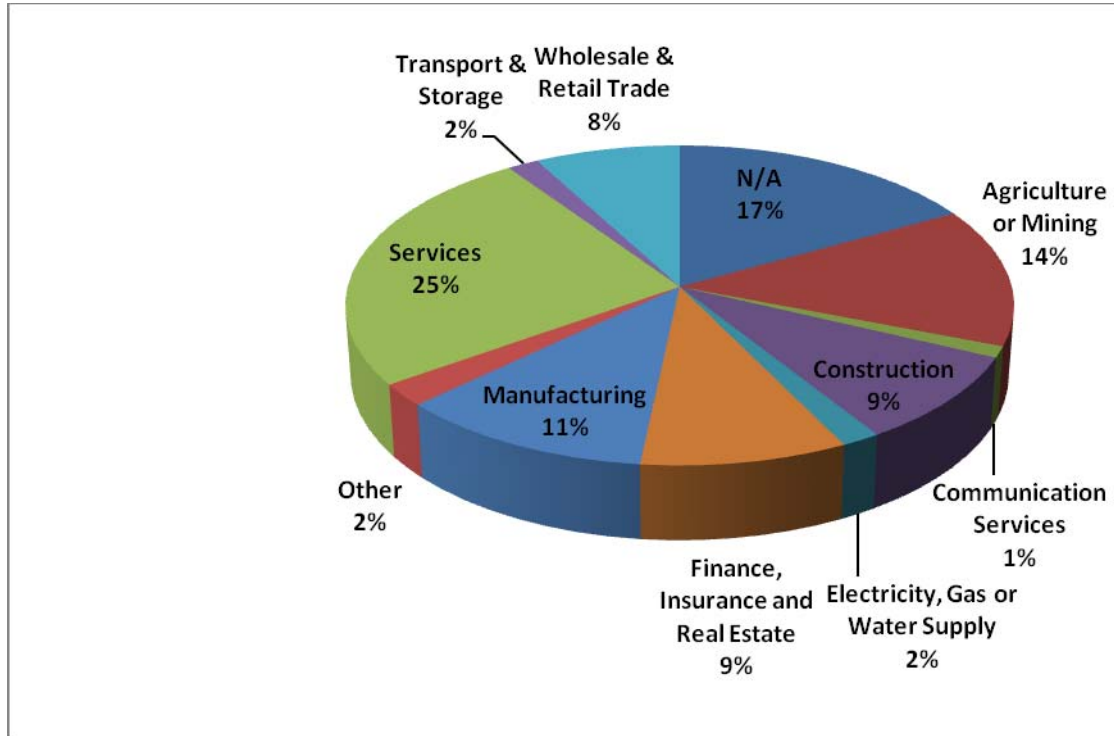
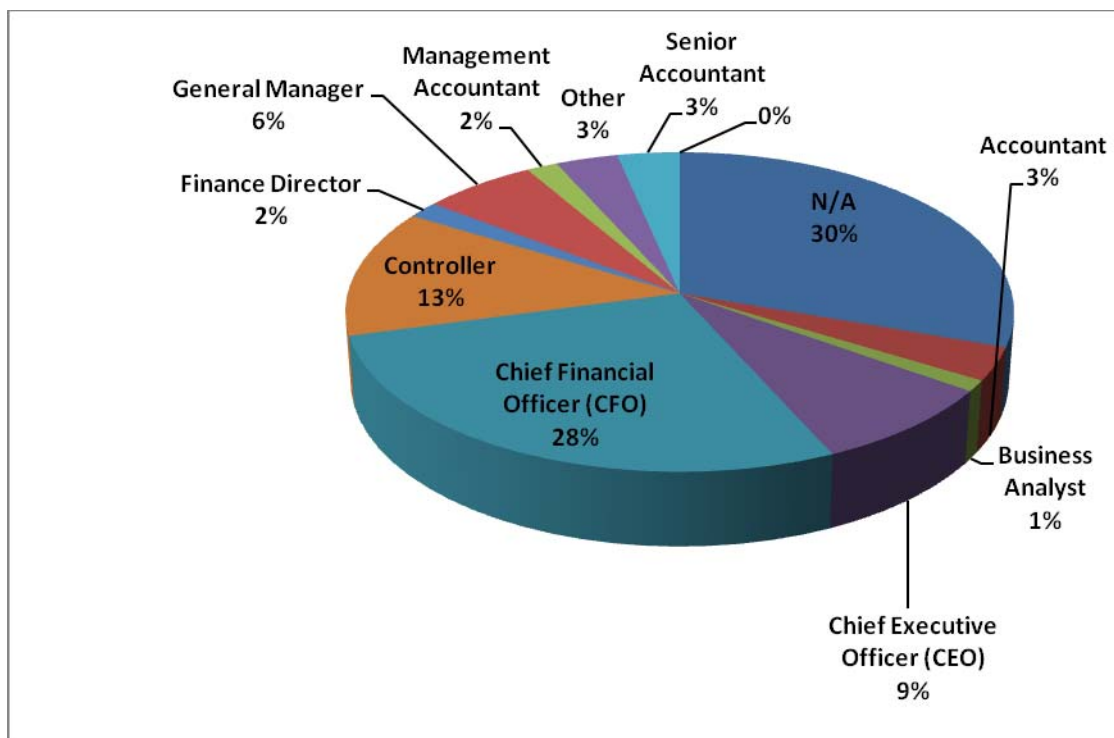


Figure 2: Distribution of respondents' job title



**Table 13: Respondents' time in their current position and respondents' time in the organisation**

**Descriptive Statistics**

	N	Minimum	Maximum	Mean	Std. Deviation
Time in current position (yrs)	147	0	31	5.92	5.970
Time in company (yrs)	146	0	36	6.99	7.448
Valid N (listwise)	146				

We hope that you have enjoyed the findings of this report. As indicated above, we shall conduct further analysis to examine significant relationships among variables. Such an analysis will be useful to understand the relationship between the use of environmental information in decision-making, innovation, and performance. Thank you for participating in this research project.

Appendix – Carbon Offset Certificate



Monash University  
Dept of Accounting & Finance  
Mr Aldonio Ferreira  
Lecturer and Researcher  
Wellington Rd  
Building 11 E

**RECEIPT**

CR003694  
20/02/2009

Monash University for 00002951

Amount : One Thousand and Eighty Dollars and 0 Cents \$1,080.00

Payment Method: Credit Card Payment Method Number: XXXX-XXXX-XXXX-

Payment Particulars

00002951	20/02/2009	\$1,080.00	\$1,080.00
----------	------------	------------	------------

Supporting Greenfleet's biodiverse forest sink program

Donation: 1 X tree per survey

Planting 360 native trees will contribute to the creation of biodiverse forests that will sequester 96.40-e CO2 tonnes from the atmosphere as they grow.

Thank you for your support.

AVOID REDUCE OFFSET

**Head Office**  
108 Horn Street, Leongatha VIC 3953  
Phone: (03) 5662 3588  
Free call: 1800 032 999  
Fax: (03) 5662 3276

**Melbourne Office**  
Suite 3, Level 10  
365 Little Collins Street, Melbourne VIC 3000  
Phone: (03) 9642 0570  
Fax: (03) 9642 8786

Email: [info@greenfleet.com.au](mailto:info@greenfleet.com.au)  
Website: [www.greenfleet.com.au](http://www.greenfleet.com.au)

Greenfleet Australia (ABN 22 095 044 465) as corporate trustee on behalf of the Greenfleet Trust (ABN 86 693 237 685)