



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 211 *usable* responses to our paper survey of senior Australian business leaders.¹ As a consequence we have made a donation to Greenfleet, on behalf of the participants, to offset the CO₂ emissions equivalent of driving cars for 211,000 km (211 x 1000 km).²

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.

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

² 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 211 responses received plus 149 responses received in online version of the same survey, totalling 360 responses.

2. The results

2.1. Univariate analysis

Performance

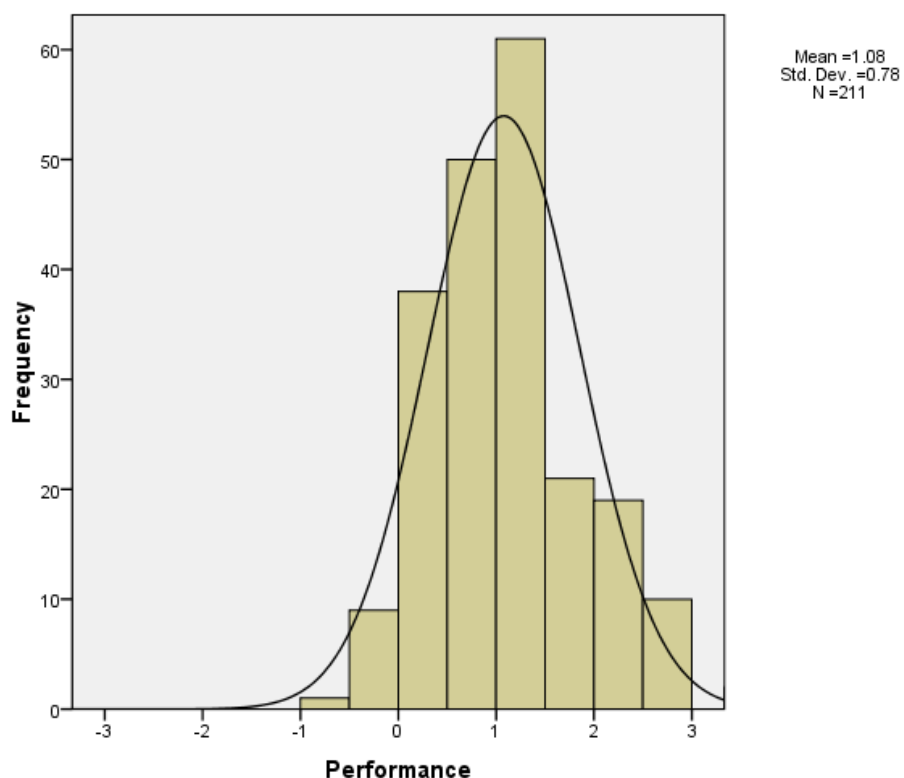
Table 1 shows different dimensions of organisations' performance. The scale used to measure performance ranged from *well below competitors* (-3) to *well above competitors* (+3). The overall performance item was obtained by weighing the performance scores by the importance scores of each dimension (as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

Table 1: Performance - Descriptive Statistics

	N	Min	Max	Mean	Std. Dev.
Short-term financial performance	210	-2	3	1.15	1.179
Customer-relations performance	210	-2	3	1.31	1.046
Employee-relations performance	210	-2	3	.90	1.054
Operational performance	210	-3	3	1.02	1.069
Quality performance	71	-1	3	1.01	.949
Alliances performance	206	-3	3	.33	1.034
Supplier-relations performance	68	-2	3	.43	.816
Environmental performance	210	-2	3	.71	.920
Innovation performance	70	-2	3	.79	1.153
Community-relations performance	211	-2	3	.65	1.009
Performance (overall)	211	-1	4	1.08	.780

The results show an overall mean of 1.08 with a standard deviation of 0.780. 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 -1). In contrast, a number of companies are positioned at the high end of the scale.

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



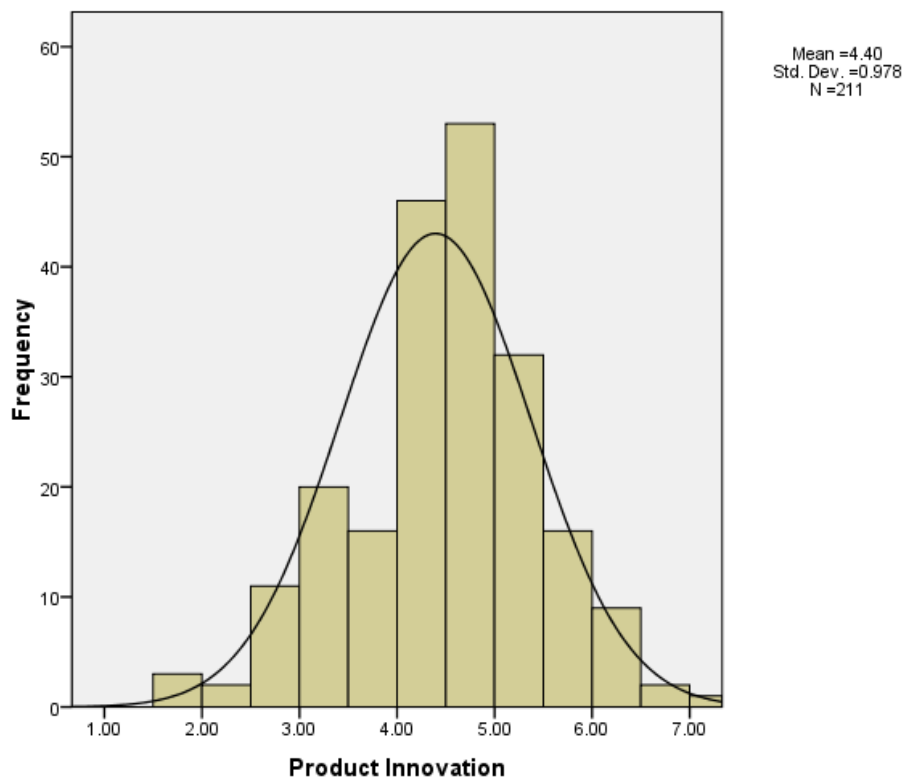
Product Innovation

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	211	1	7	4.57	1.421
My company has launched many modifications to already existing products/services	211	1	7	4.73	1.363
My company is very often the first-to-market new products/services	211	1	7	4.42	1.396
The percentage of new products/services in my company's product portfolio is much higher than the industry average	211	1	7	4.12	1.302
Our new products/services are minor improvements in a current technology	210	1	7	4.57	1.101
Our new products/services incorporate a large new body of technological knowledge	211	1	7	3.98	1.395
Product Innovation	211	1.50	7.00	4.40	0.978

The results in Table 2 show that, on average, the organisations displayed a moderate level of product innovation with a mean of 4.40 (standard deviation of 0.978) and a distribution approximately normal. The findings also show that a number 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.

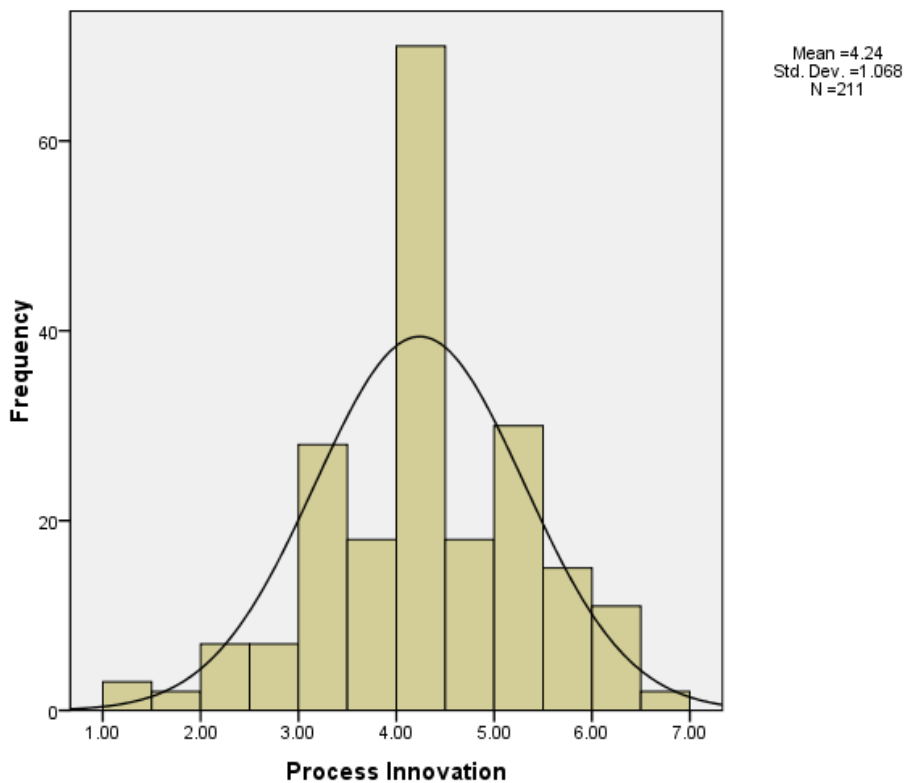
The degree of process innovation in firms was measured by using five items and the results show that, on average, the organisations studied are moderately innovative with respect to processes (mean of 4.24 and standard deviation of 1.068). The distribution of the process innovation variable shows an approximately normal

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

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	211	1	7	4.25	1.347
My company has introduced many modifications to production/service processes	211	1	7	4.44	1.242
My company is very often the first to introduce new production/service processes	211	1	7	4.12	1.269
The frequency of production/service process improvements in my company is much higher than the industry average	211	1	6	4.14	1.173
The degree of innovativeness of my company's technology is much higher than the industry average	211	1	7	4.26	1.239
Process Innovation	211	1.00	6.60	4.24	1.068

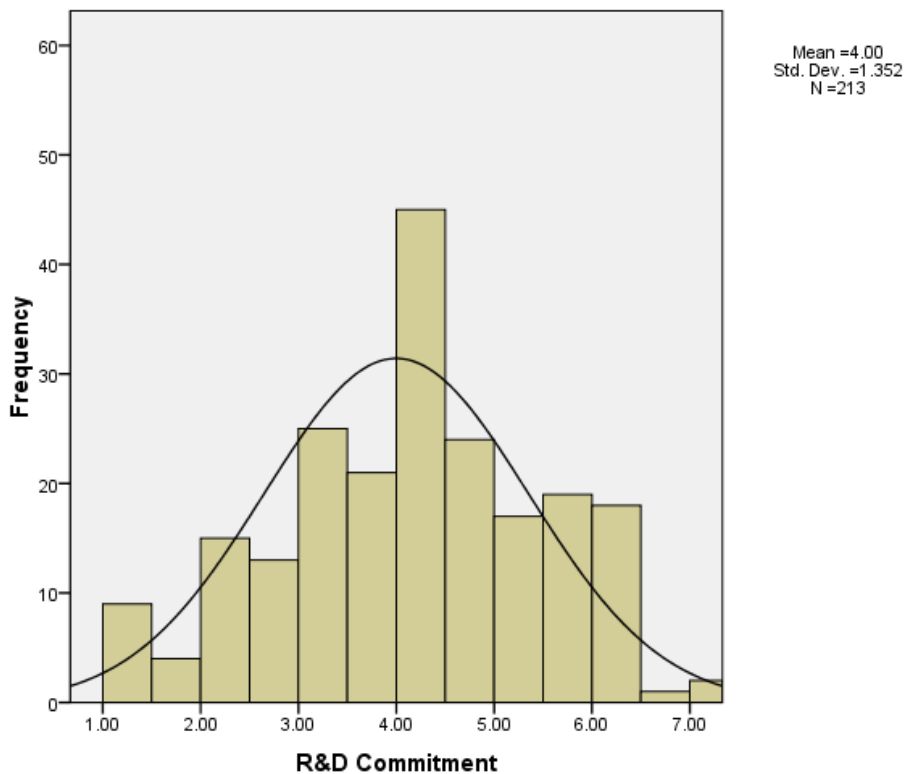


R&D Commitment

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	212	1	7	3.87	1.331
My company places a strong emphasis on R&D, technological leadership, and innovation	213	1	7	4.30	1.518
My company is serious about investment in R&D	213	1	7	4.24	1.525
My company is a R&D intensive organisation in its industry	213	1	7	3.58	1.504
R&D Commitment	213	1.00	7.00	4.00	1.352



The results show that the organisations have moderate to low commitment to R&D investment, with a mean of 3.40 and a standard deviation of 1.352. 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.

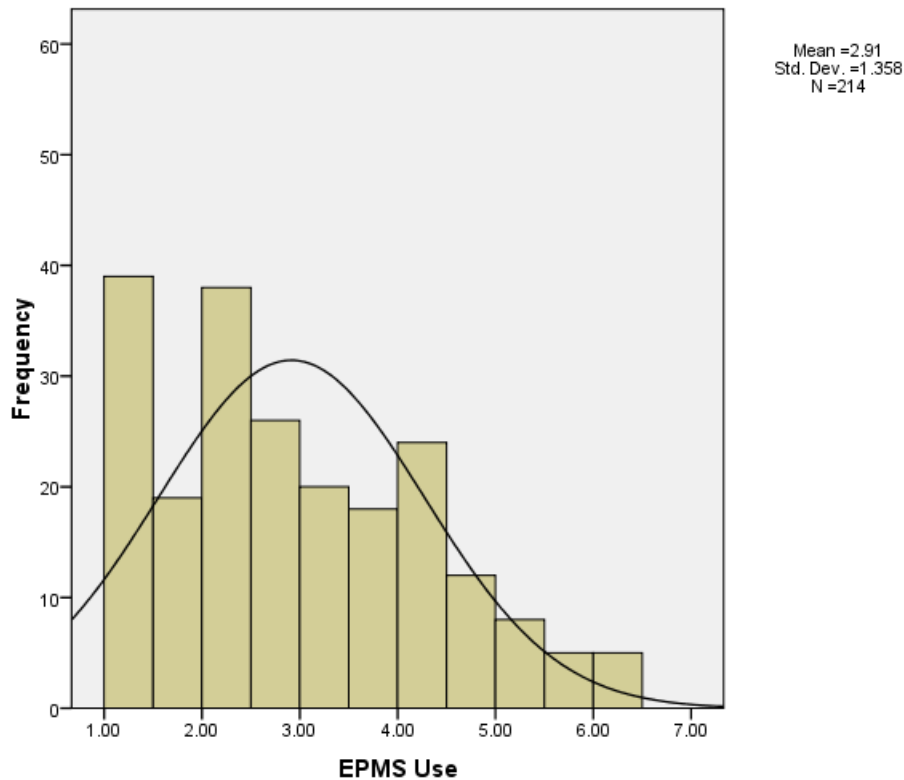
EPMS Use

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	214	1	7	3.93	1.743
Identification of environmental costs borne by the community	213	1	7	2.79	1.577
Estimation of environmental contingent liabilities (e.g. EPA fines)	214	1	7	3.15	1.744
Classification of environmental costs	212	1	7	3.19	1.687
Allocation of environmental costs to production processes	212	1	7	2.60	1.577
Allocation of environmental costs to products	214	1	7	2.50	1.571
Engaging in environmental cost management activities	214	1	7	3.34	1.771
Creation and/or use of environmental cost accounts	213	1	7	2.26	1.519
Development and/or refinement of environmental key performance indicators (KPIs)	214	1	7	3.20	1.916
Use of environmental key performance indicators (KPIs) in performance evaluations	214	1	7	2.72	1.788
Introduction of environmental impact assessments in capital investment appraisals	214	1	7	2.89	1.780
Preparation of product life-cycle cost assessments	213	1	7	2.62	1.614
Benchmarking of your environmental performance against best practice	214	1	7	3.03	1.823
Integration of environmental strategies with the overall business strategy	213	1	7	3.31	1.865
Integration of the environmental management accounting system into business management systems	214	1	6	2.19	1.376
EPMS use	214	1	6.4	2.91	1.358

The results in Table 5 show that the studied organisations display a low level of EPMS Use, with a mean of 2.91 (standard deviation of 1.358). 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

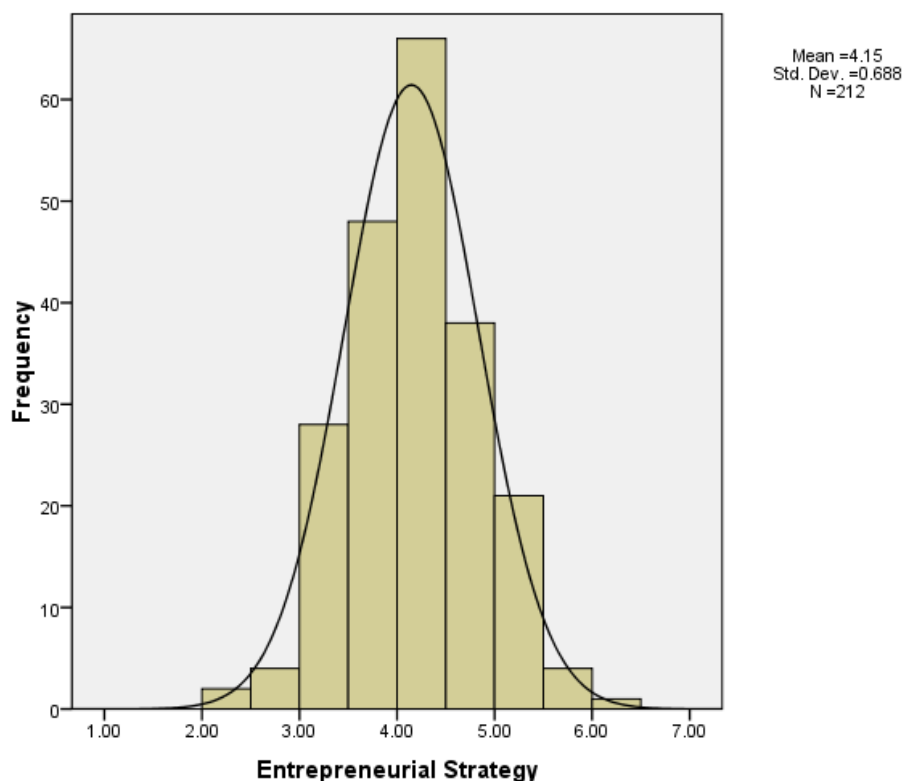
Entrepreneurial strategy, which contrasts with conservative strategy, is a measure of the proclivity of the organisation to embrace change through innovation. In the past, conservative strategies used to be more predominant because innovation and change were not traditional state of affairs for organisations. 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 4.15 (standard deviation of .688). The distribution of entrepreneurial strategy shows a relatively normal distribution. This suggests that entrepreneurial strategies are more common than they used to be, although there is still a predominance of conservative strategies.

Table 6: Entrepreneurial Strategy - 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 (#)	21 2	2	7	4.93	1.152
My company has marketed new lines of products or services in the past 3 years	21 2	1	7	5.29	1.454
My company made mostly minor changes in product or service lines in the past 3 years (#)	21 2	1	7	4.43	1.310
My company typically responds to actions which competitors initiate (#)	21 2	1	7	3.87	1.408
My company is very seldom the first business to introduce new products/services, administrative techniques, operating technologies, etc. (#)	21 2	1	7	3.48	1.481
My company typically seeks to avoid competitive clashes, preferring a "live-and-let-live" posture (#)	21 2	1	7	3.10	1.406
The top managers of my company have a strong natural inclination for low risk projects (with normal and certain rates of return) (#)	21 2	1	7	4.18	1.489
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 (#)	21 2	1	7	4.25	1.269
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 (#)	21 1	1	7	3.79	1.399
Entrepreneurial Strategy	21 2	2.00	6.00	4.15	0.688

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



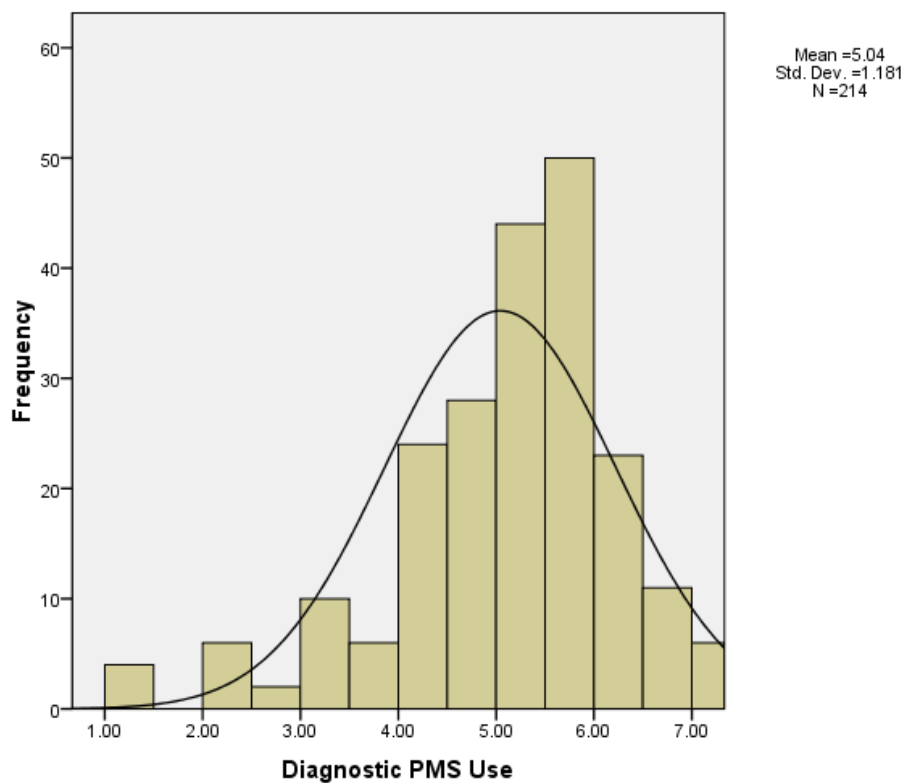
Diagnostic PMS Use

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	214	1	7	4.84	1.361
The PMS is used to track progress towards pre-established goals	214	1	7	5.01	1.291
The PMS is used to monitor the company's results	214	1	7	5.17	1.374
The PMS is used to compare outcomes to expectations	214	1	7	5.21	1.270
The PMS is used to review key performance indicators	213	1	7	5.30	1.346
The PMS is used to plan how operations are to be conducted in accordance with the strategic plan	214	1	7	4.78	1.361
Top managers use the PMS to review performance and follow up on exceptions	214	1	7	4.99	1.348
Diagnostic PMS Use	214	1.00	7.00	5.04	1.181

The results show a moderate to high level of diagnostic PMS use, with a 5.04 mean (standard deviation of 1.181). 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

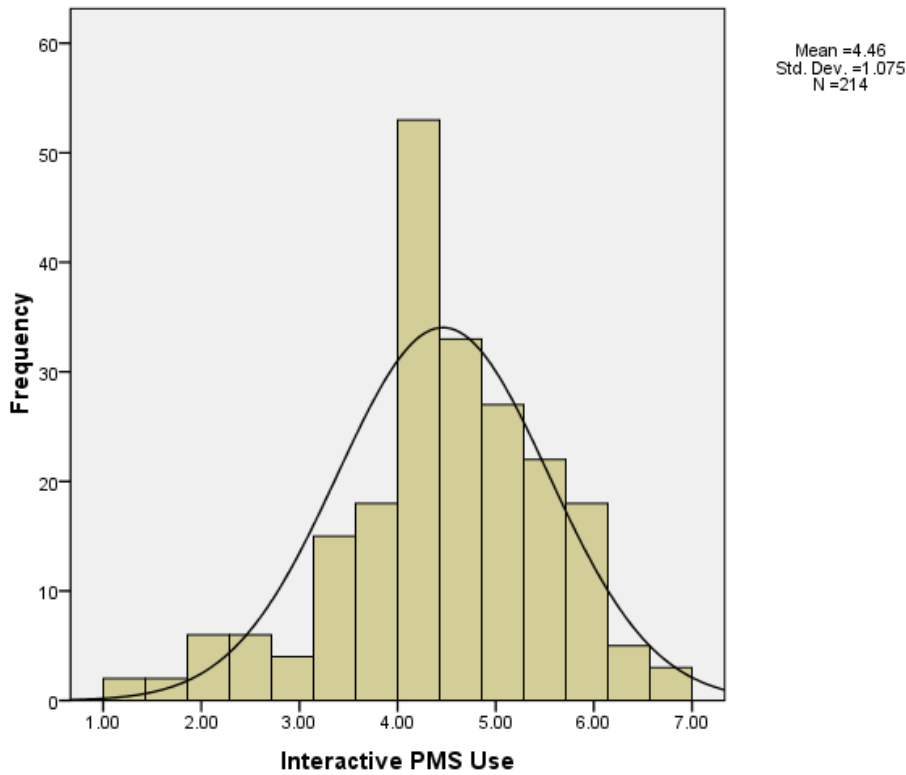
The level of interactive use of performance measurement systems was measured by five items, as outlined in Table 8. It is important to understand how organisations use their formal control systems to achieve organisational objectives. The different styles of use of PMS can assist managers to solve problems 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 4.46 (standard deviation of 1.075) 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	214	1	7	4.92	1.410
There is intensive use of the PMS by operational managers	214	1	7	4.82	1.366
The PMS focuses on the strategic uncertainties facing the company	213	1	7	3.97	1.249
Top managers have a non-invasive, facilitating and inspirational involvement with regards to the PMS	214	1	6	4.13	1.183
The PMS is used regularly and frequently in face-to-face meetings between operational and top managers	214	1	7	4.48	1.462
Interactive PMS Use	214	1.00	6.80	4.46	1.075



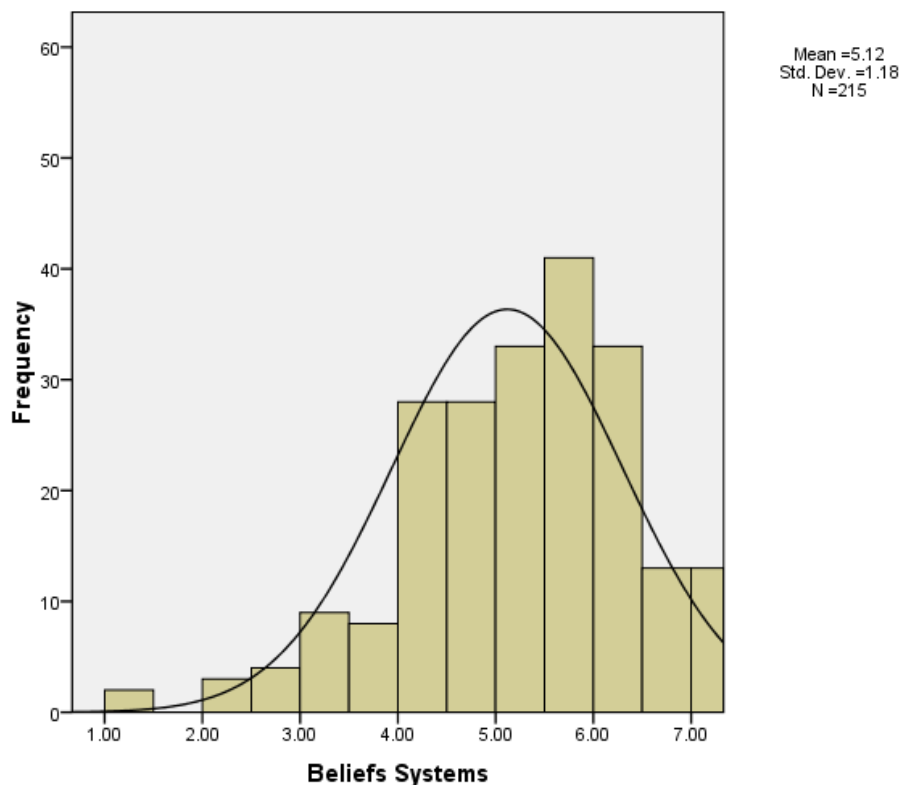
Beliefs Systems

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	215	1	7	5.48	1.420
Top managers communicate core values to our workforce	215	1	7	5.34	1.216
Our workforce is aware of the company's core values	215	1	7	5.16	1.310
Our mission statement inspires our workforce	215	1	7	4.48	1.443
Beliefs Systems	215	1.00	7.00	5.12	1.180

The results show that the organisations have a moderate to high level of beliefs system instilled into their companies (mean of 5.12 and standard deviation of 1.180). 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.

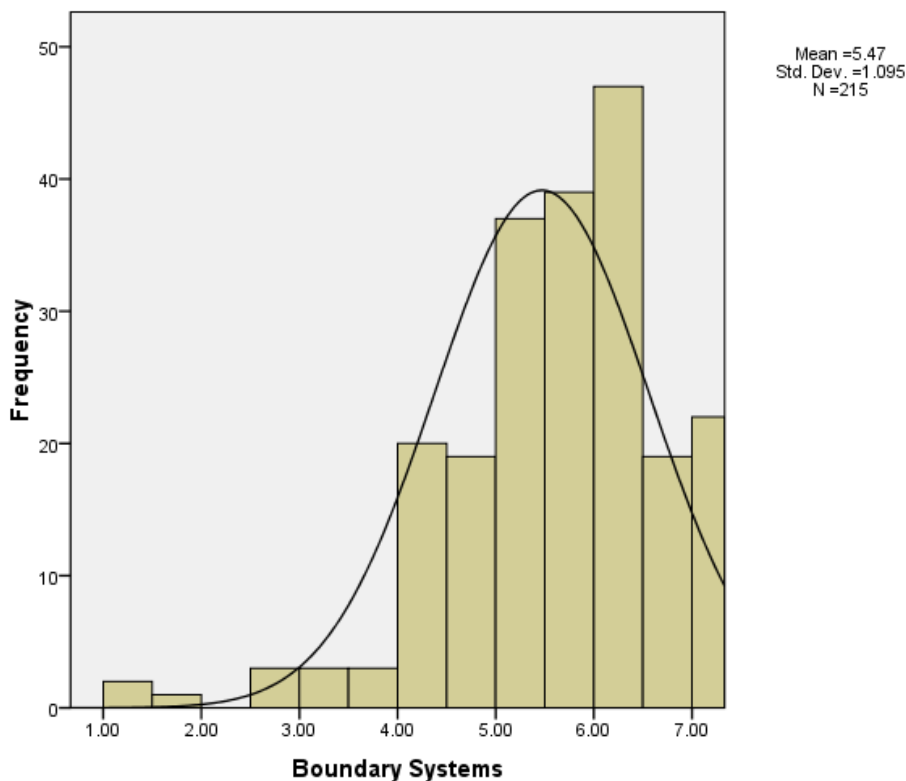


Boundary Systems

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	215	1	7	5.44	1.288
Our code of business conduct informs our workforce about behaviours that are off-limits	215	1	7	5.63	1.253
Our company has a system that communicates to our workforce risks that should be avoided	215	1	7	5.43	1.232
Our workforce is aware of the company's code of business conduct	214	1	7	5.38	1.297
Boundary Systems	215	1.00	7.00	5.47	1.095



Respondents have rated the level of boundary systems within their organisations as being high, with a mean of 5.47 and a standard deviation of 1.095. 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

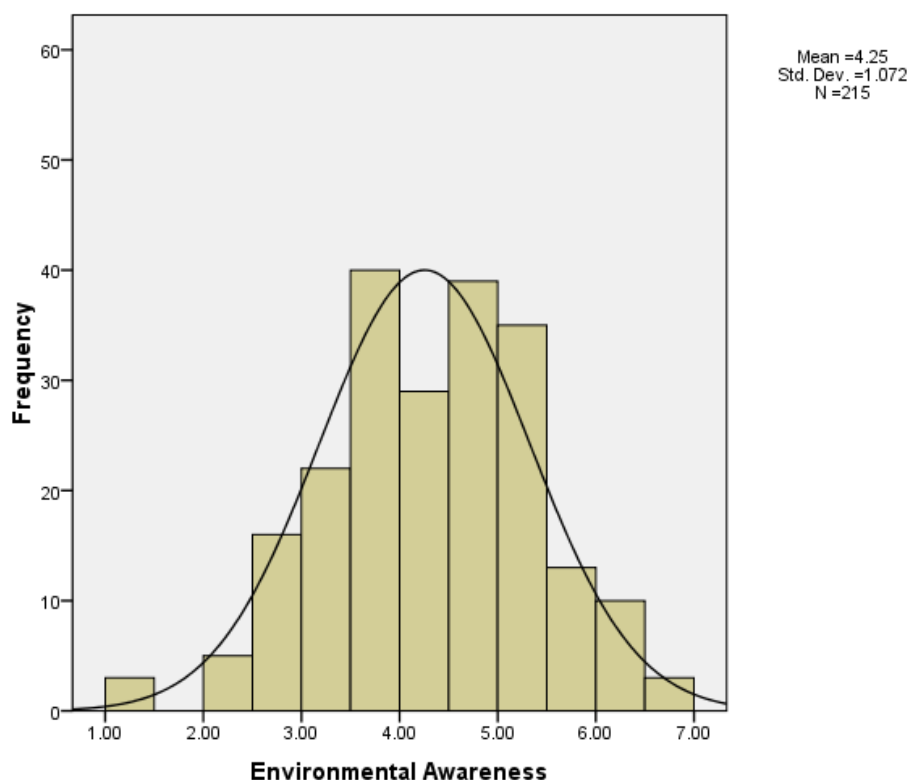
Environmental Awareness is a measure of the extent to which companies expect to be affected by changes and pressures deriving from their institutional environments and stakeholders as a consequence of environmental concerns (e.g. climate change). The variable comprised eight items, ranging from changes 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	215	1	7	4.63	1.574
Changes in government regulations	215	1	7	5.13	1.447
Changes in the nature of competition	215	1	7	4.60	1.488
Changes in the availability of natural resources	215	1	7	4.27	1.735
Pressure from employees to change business practices	215	1	7	3.82	1.439
Pressure from shareholders to change business practices	215	1	7	3.67	1.740
Pressure from suppliers to change business practices	215	1	7	3.40	1.423
The introduction of a carbon trading scheme	215	1	7	4.52	1.710
Environmental Awareness	215	1.00	6.88	4.25	1.072

Table 11 shows that respondents rated environmental awareness at a moderate level, with a mean of 4.25 and standard deviation of 1.072. 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

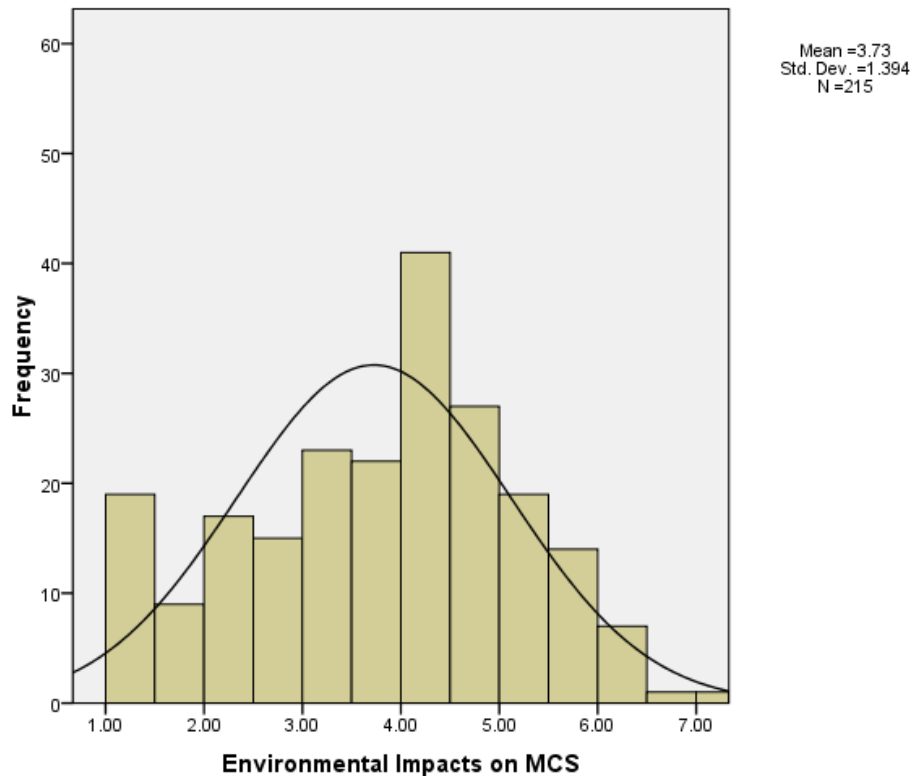
Participants were asked to indicate the extent to which they expected the internal systems of their companies to be affected by the introduction of a carbon trading scheme. This included nine sub-systems that form part of the broader performance measurement and control system.

Table 12: Environmental Impact on PMS - Descriptive Statistics

	N	Min	Max	Mean	Std. Dev.
Performance measurement systems	215	1	7	3.88	1.655
Costing systems	215	1	7	4.08	1.751
Financial reporting systems	215	1	7	4.13	1.683
Senior management compensation systems	215	1	7	3.11	1.534
Employee compensation systems	214	1	7	2.91	1.449
Transfer pricing systems	214	1	7	3.13	1.675
Capital investment appraisal systems	215	1	7	4.07	1.717
Strategic management systems	215	1	7	3.97	1.645
Risk management systems	215	1	7	4.23	1.650
Environmental Impacts on PMS	215	1.00	7.00	3.73	1.394

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

With a mean of 3.73 (standard deviation of 1.394), 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 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.



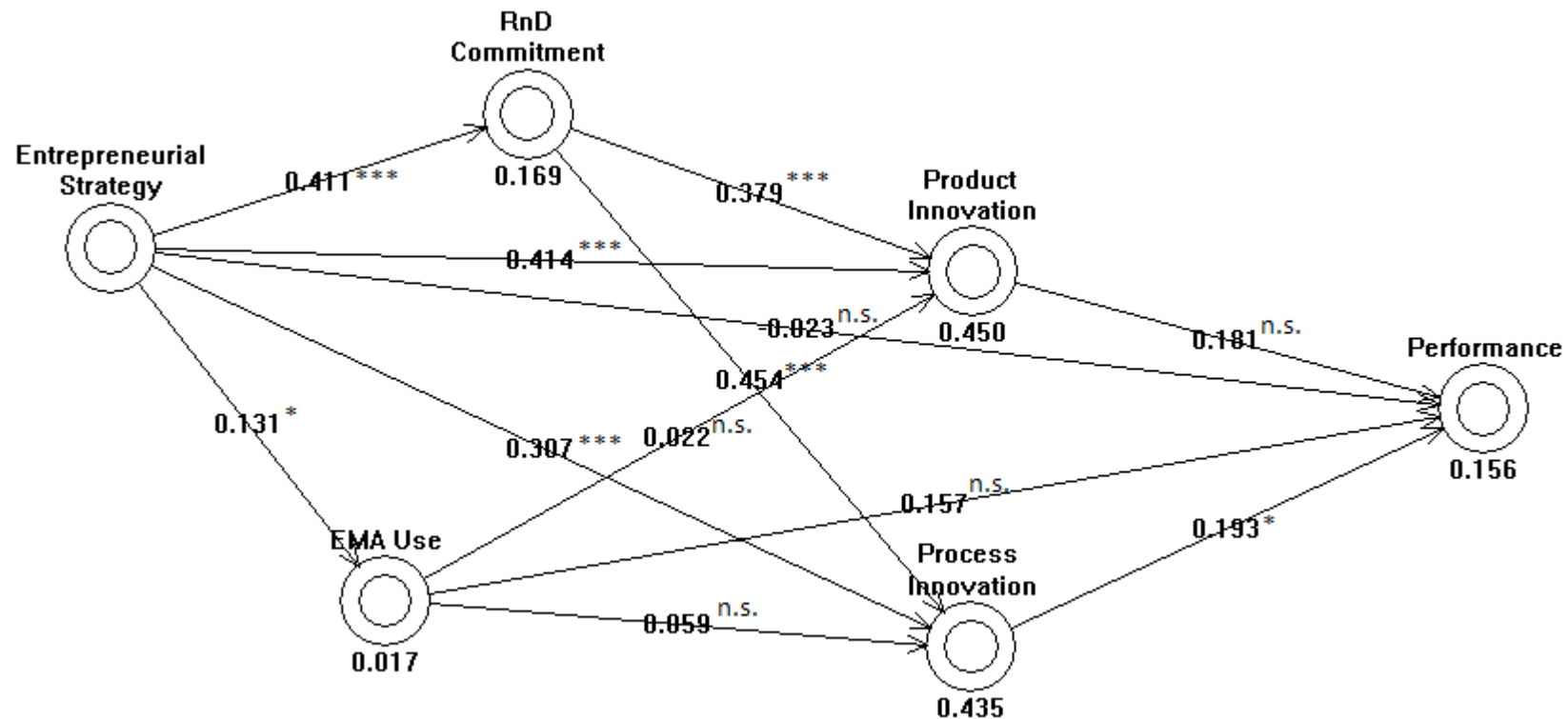
The distribution of Environmental impacts on PMS is slightly positively skewed with a long tail of distribution at the higher end of the distribution. This is a consistent pattern when compared to environmental awareness (both distributions are approximately normal). However, the distribution of environmental 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 process innovation. The effect of both product innovation and the use of environmental performance measurement systems (EPMS) on performance is not statistically significant (even though it is commensurate with that of process innovation).
- The use of EPMS has no significant effect on either process innovation or product innovation, a finding that is surprising as these are frequently argued as some of the benefits of EPMS Use. This finding is also partially inconsistent with other research and will be subject of further investigation.
- Companies following entrepreneurial strategies are more likely to use EPMSs.
- As expected, R&D commitment shows a very strong and significant 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. The analysis also indicates no significant relationship between entrepreneurial strategy and performance, suggesting that both entrepreneurial and conservative strategies are associated with high performance 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. 16.9% 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

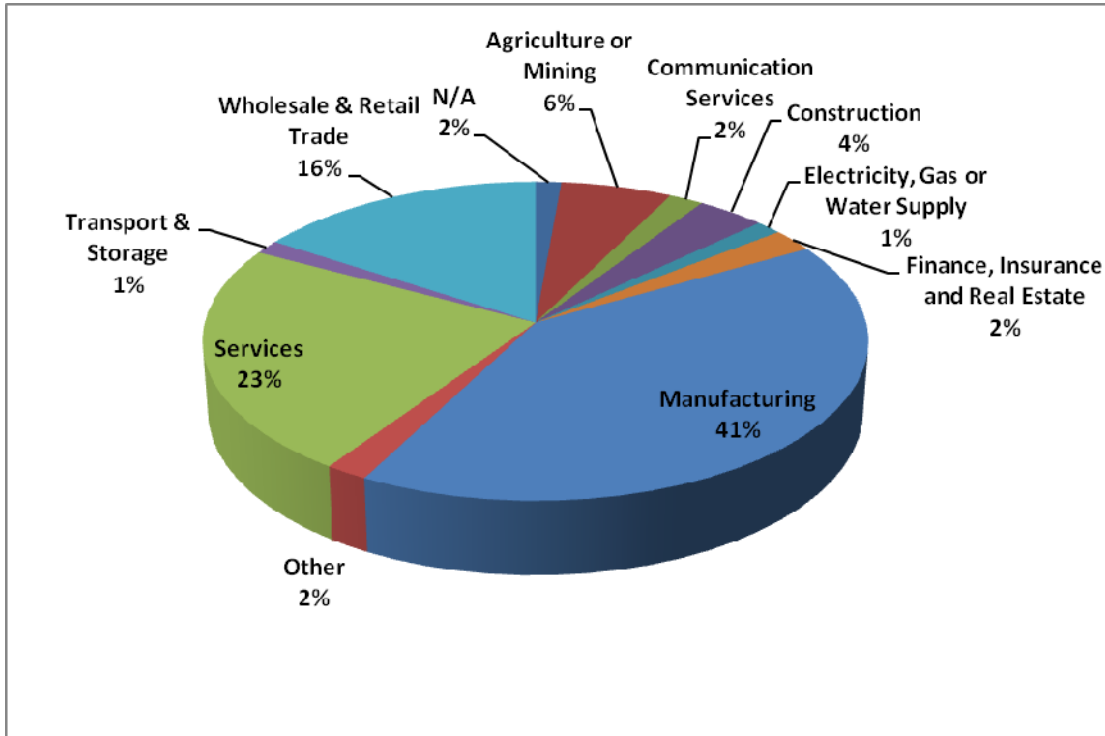


Figure 2: Distribution of respondents' job title

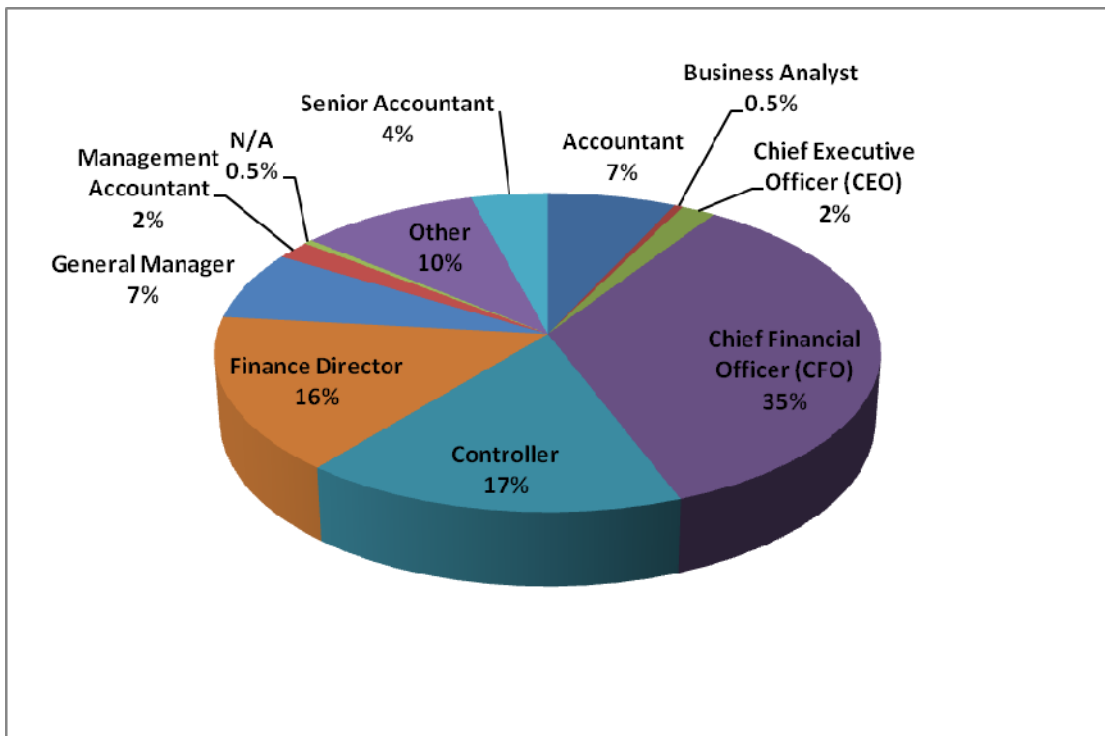


Table 13: Respondents' time in their current position and respondents' time in the organisation

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Time in current position (yrs)	213	0	30	6.48	5.845
Time in company (yrs)	211	0	36	9.53	7.707

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.



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
Website: 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)