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Variance analysis and performance: two empirical studies

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Abstract

When variances are investigated, a substantial amount of information can be generated which is often discarded once managers have explained the variance to superiors. This paper argues that discarding such information is wasteful for problem solving. Evidence from two empirical studies, a longitudinal field study in a single organization and a cross sectional study, is presented which provides evidence that retaining and analyzing this information is associated with improved performance in problem solving. © 1999 Elsevier Science Ltd. All rights reserved.

Relatively little research in management accounting is motivated from observing management accounting practice but such observations can raise a number of interesting research questions, especially where management accounting practices are changing. Such changes can prompt questions about the change process as well as whether such changes affect performance and other valued outcomes.

This paper reports a change that was made to the system of variance analysis in the production department of a manufacturing company and examines its effect on performance. The paper describes the change along with reasons why it might improve problem solving performance. Performance is then examined longitudinally and, after controlling for various confounding variables, the results suggest that performance improved after the change to variance analysis was made. This result motivated the researcher to replicate the study cross-sectionally in order to examine whether the

results in the longitudinal study were generalisable to other organisations and to increase convergent validity between the studies (Birnberg, Sheilds, & Young, 1990; Locke, Smith, Erex, Chah & Schaffer, 1994).

While this study was motivated by observing a change to variance analysis practice and examining its effect on performance, ultimately, any effect needs to be explained theoretically. Consequently, a number of theories are discussed which provide an ex post explanation for the results from which a more comprehensive theoretical framework can be developed.

1. Variance analysis and problem solving

Variance analysis seeks to understand the difference between actual performance and some planned or targeted level of performance and is an important form of organizational feedback (Luckett & Eggleton, 1991). Variance analysis can be described as a three stage process where the first stage calculates the variances; the second stage

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identifies the problems which have generated the variances and the third stage identifies the causes of those problems. However, while management accounting texts describe the calculation of variances in great detail, they are largely silent on the latter two stages of the process and, in particular, the third stage. For example, Horngren and Foster (1990 p. 826) say that “correcting the source of a variance entails finding the underlying cause...and eliminating it” but they do not offer any advice about how to identify these underlying causes of problems.

The change to variance analysis that is reported in this study concerns the third stage of the variance analysis process; that is, having identified the problems that have generated the variances, how can the causes of these problems be identified?

1.1. Identifying the causes of problems

Investigating variances can generate a considerable amount of information about the problems that have caused variances. In the production department where the change to variance analysis occurred, this information was largely used to explain the problems to superiors and, where the causes were obvious, to also solve those problems. Thereafter, this information was discarded and seldom used again. This paper argues that for solving those problems whose causes are *not* obvious, discarding information about problems is potentially wasteful.

The cause of a problem is *not* obvious where the ‘signal’ relating to the cause cannot be differentiated from the ‘noise’ of other potential causes. Without knowing what has caused a problem it cannot be solved and, consequently, the problem is likely to recur and may recur several times before the manager can identify what is causing the problem. As it recurs, the manager will increasingly treat a potential cause as the actual cause if it correlates highly with the incidence of the problem; that is, it produces an increasingly strong ‘signal’ that stands out from the ‘noise’.

For example, if a particular problem occurs when product A is being made, the manager might not draw any conclusion the first time this occurs. But if the problem recurs, and only seems to recur when product A is made (rather than when pro-

ducts B, C and D are made), this knowledge will increasingly lead the manager to investigate what it is about product A (or something correlated to product A) that might be systematically causing the problem. While this process of correlating problems with potential causes does not guarantee that the potential cause is the actual cause, relative to other possibilities, it provides a promising avenue of investigation that can expedite the problem solving process.

The more ways that problems can be correlated against potential causes (e.g. by product, supervisor, shift, etc), the greater the likelihood that unexpected relationships between problems and potential causes will be identified. This process is consistent with the observation by Feldman and March (1981, p. 176) that managers often collect information which has no immediate apparent value in order to “search for surprises” which can enhance their understanding of the operating environment.

In the production department that formed the longitudinal study, rather than discard the information about problems which had caused variances, the information was retained on a database which summarized problems in a number of ways, for example, by product, shift and location.

Storing this information on a database helps managers to overcome the problem of bounded rationality which affects managers ability to memorize problems and analyze what is systemic about them (Newell & Simon, 1972; Simon, 1957).

Without being able to overcome the problem of bounded rationality, individuals are likely to solve problems in less appropriate ways, such as drawing conclusions from incomplete data. Such conclusions are more likely to be misplaced, not only because the conclusion is based on incomplete data, but also because the process is subject to an individual’s prejudices and biases. Storing the information on a database not only relieves the individual from memorizing problems and correlating them with potential causes but is more likely to do so unbiasedly.

This discussion leads to the following hypothesis:

A manager’s performance will improve where the management accounting system retains information

about problems and correlates them against an increasing number of potential causes.

2. Longitudinal study

The longitudinal study was based at a large chemical manufacturer where the researcher was present on an intermittent basis for a period of 18 months. During this time the researcher became familiar with the production department where the change to variance analysis was made.

The longitudinal study is organized in the following way. The operationalisation of the independent and dependent variables is detailed first. The independent variable is described in terms of how problems were summarized against potential causes and how this information was used to solve problems. The dependent variable of performance is measured in terms of the two goals in the production department: output and quality. Some timing issues then need to be clarified before examining whether performance improved after the change to variance analysis was made. Finally, a discussion about how potential confounding factors were controlled is presented.

2.1. Operationalizing the independent variable: retaining and analyzing information about problems

The criterion for determining whether the independent variable had been operationalized was to examine the *number* of different ways problems were analyzed; that is, the number of different potential causes that problems were correlated or summarized against. This task was achieved by examining company documents that provided evidence about the use of variance analysis before and after it was changed. (For reasons of brevity, the actual documentation is not replicated in this paper but they are available from the author.)

Before the change, variances against output and quality targets were calculated daily and any adverse variance was discussed at a daily production meeting where the problems causing these variances were identified. These problems were

listed on a weekly report which was retained as a hard copy in a filing cabinet (about 10–12 problems a week were recorded). The report listed each problem, the date that it occurred, the loss (in terms of tonnes of production lost or downgraded), and identified which of the two production lines the problem occurred on. Consequently, it was possible, though cumbersome, to leaf through the various hard copies of the weekly reports and correlate the problems against the two production lines in order to identify whether a disproportionate number of problems occurred on one production line or the other.

After the change, problems were listed on a computer database as well as a hard copy which considerably facilitated the ability to correlate problems with potential causes. In addition to information about which production line problems occurred upon, the data retained on the database included five other potential causes; namely, (i) the product that was being made when the problem occurred; (ii) whether the problem occurred during a change over; (iii) the shift that was working; (iv) the supervisor that was working; (v) where in the plant the problem occurred (location); and (vi) a cause category (hardware, logistical operational, etc).

Consequently, after the change, information about problems could be correlated against five additional potential causes compared to before the change. Given that the criterion for determining the operationalization of the independent variable was the number of different ways problems could be summarized, this evidence provides support that the independent variable was operationalized.

2.2. How the information from variance analysis was used for problem solving

The information on the database was used and analyzed in three main ways. First, a list of the problems that had caused variances was presented at a weekly production meeting and this process ensured acceptance of the data and guaranteed a captive audience to whom to communicate the results. This process was important because it ensured that the feedback was communicated, accepted and understood.

Second, the problems on the database were summarized against potential causes to identify areas where a disproportional number of problems existed. For any given problem area, a small problem solving team would be assembled (depending on the skills and experience needed) to try and solve these problems. For those problems that had occurred within that area, the team would further interrogate the information on the database to identify any unexpected relationships between problems and potential causes. For example, if process A was being focused on, those problems that had occurred within process A could be examined to identify whether a disproportionate number of problems occurred when particular products were being produced or whether certain change-overs were more problematic than others.

The third way the information was used was in providing data to raise and substantiate issues with parties external to the plant. For example, the reliability and quality of raw materials was a problem and prompted the establishment of a co-ordinating body between the plant and supplier to raise and resolve these issues.

2.3. Operationalising the dependent variable: performance

Performance was measured in terms of two goals: output (in terms of tonnes) and quality (in terms of the percentage of output within product specifications).¹ The performance data was sourced from company documentation and is described as objective because the figures were verified from various sources (Cronbach, 1970). However, before the data are analysed, there are three timing issues that need to be resolved and these are discussed next.

2.4. Timing Issues

The first timing issue to consider relates to identifying the date when the changes became

operational; the second concerns the lag from when the information became available to the time when it could be seen to affect performance; and the third relates to the length of the data collection period. These three issues will now be discussed in turn.

The first timing issue relates to the date when the change became operational and this date was determined by plant management. Some time before implementing the change, plant management held a meeting to consider whether the change should be approved since it had several resource implications. At that meeting, plant management were shown a prototype of the sort of information that could be produced but at that time the information on the database was not used to solve problems; only to determine whether or not the change should be approved. Plant management considered the potential costs and benefits of such a system and not only approved the implementation of the system but also determined the date when the information would become operational.

The second timing issue concerns the length of time from when the new information was introduced to when it would have affected performance. The researcher asked the operational manager about this issue and his response was that some improvements would have been felt immediately because the database already had several months of data that had been collected for the prototype. Consequently, there was enough information about problems such that meaningful analyses could be conducted as soon as the database was made operational.

The third timing issue relates to how long (before and after the change) the performance data should be collected for. Data were collected about performance on a weekly basis for 36 weeks before the change and for 29 weeks after the change. Performance data were collected for a longer period before the change than after because it was necessary to examine whether performance was improving for any other reason that could have confounded the effect of the change to variance analysis. With regard to the performance data after the change, 29 weeks of data was collected because this was long enough for the effect

¹ The longitudinal study measures the department's performance but this reflects the manager's performance (per the hypothesis) to the extent that the manager is responsible for the department's performance.

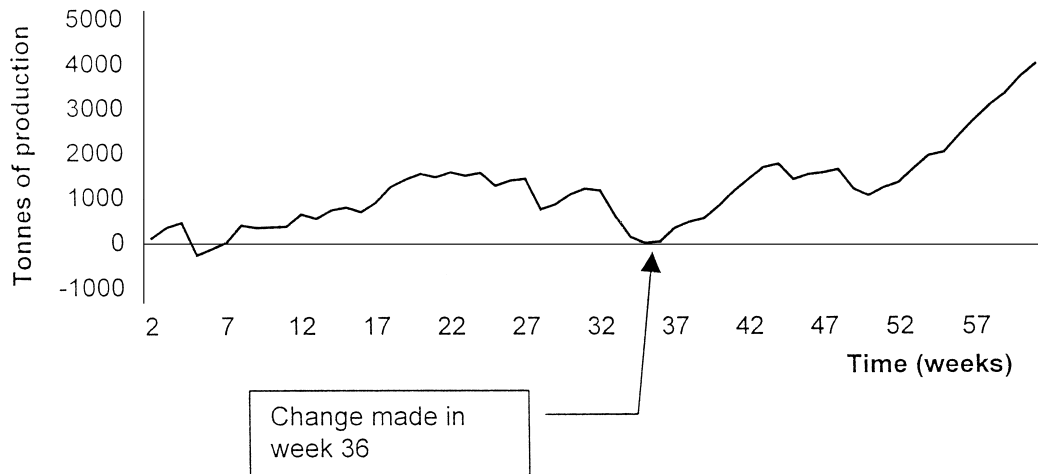


Fig. 1. Cumulative improvement in output performance (tonnes).

on performance to be felt but short enough to minimize the threat from other confounding factors. Furthermore, this length of time is consistent with other field feedback studies (Kopelman, 1986, p. 134).

2.5. Data analysis and results

In order to test the hypothesis, the data were examined both graphically and statistically to identify whether mean performance improved after the change was made; that is, was the average (mean) performance for the 29 weeks after the change greater than the average (mean) performance for the 36 weeks before the change.²

The data were graphed using a cumulative performance index which compares performance before the change to after the change. The cumulative performance index was calculated by subtracting the average (mean) performance for the 36 week period before the change from the value

of each data point resulting in a positive (or negative) figure where performance was greater (or less) than the mean. The product of this calculation was accumulated and plotted over time and is presented in Fig. 1 for the output performance data and Fig. 2 for the quality performance data. Cumulative performance reduces to zero at the point when the change occurred i.e. week 36 (where the cumulative performance equals the mean for the first 36 weeks), thereafter, performance noticeably improves for both output and quality.³

These graphs indicate that performance increased after week 36, though noticeably more consistently for quality than output. The results for quality are arguably a better indicator of performance than output because they were less subject to influences outside the plant. For example, in Fig. 1 the supply of raw materials accounted for much of the dip in output around weeks 30–36 (i.e. before the change) and weeks 44–51 (i.e. after

² To examine whether performance was improving prior to the change (which could have confounded the results), the data for the 36 weeks before the change was regressed against the output and quality performance data and the sign of the beta coefficient examined. The coefficient was negative but insignificant for both output and quality, indicating that performance was decreasing rather than increasing prior to the change and, consequently, would not have confounded the results.

³ The data were checked for autocorrelation by correlating the performance data for output and quality against itself lagged one, two and three weeks. All correlations were insignificant, except for the output data lagged one week that probably occurred when a problem occurring at the end of one week affected the following week's performance. Consequently, week 36 data was correlated with week 37 but this effect did not continue beyond week 37 and did not affect the overall results.

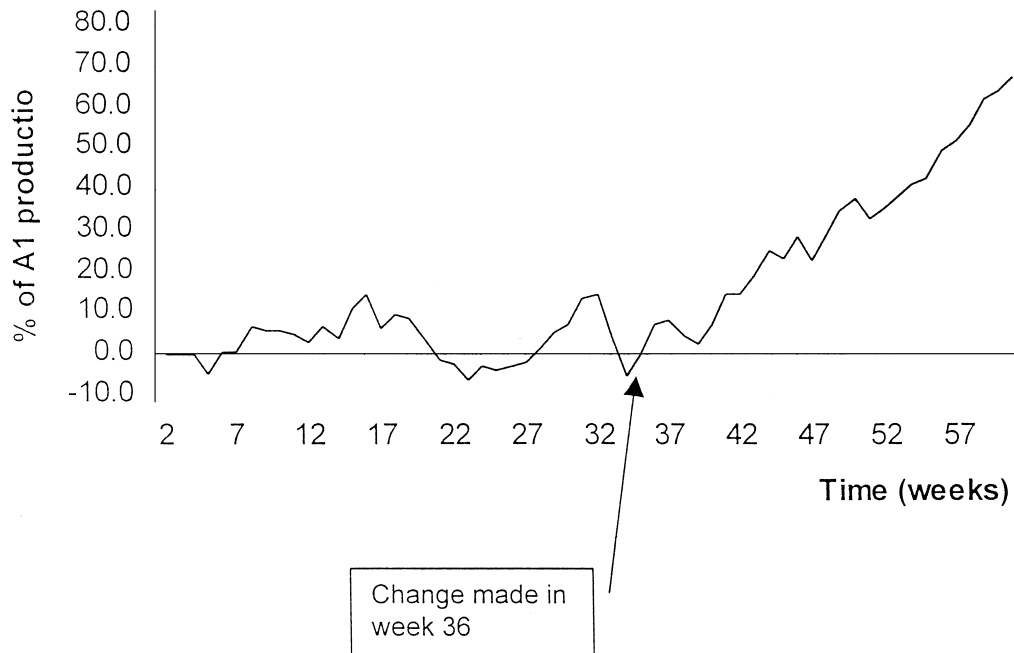


Fig. 2. Cumulative improvement in quality performance (%A1).

the change). (These two periods largely off-set each other and including or excluding the data does not significantly affect the results.)

These changes in performance are now quantified more precisely using a *t*-test that measures whether there is a significant change in the mean performance after the change. The results of the *t*-test are given in Table 1 below.

A positive *t*-ratio and a significant *p*-value (based on a one-tailed test at the 5% level of significance) indicates that a significant improvement in performance occurred after the change for both output ($p=0.008$) and quality ($p=0.009$). This evidence supports the graphical evidence that performance improved after the change.

2.6. Controlling confounding factors

While there are several advantages with a longitudinal field study of this type, probably the biggest disadvantage relates to the researcher's ability to control potential confounding factors.

In terms of the lack of control over the plant and its environment, the researcher's familiarity with the plant was advantageous because certain

Table 1
Comparative performance before and after the change

	Output	Quality
<i>t</i> -Ratio	2.45	2.41
<i>p</i> -Value (one-way)	0.008	0.009

potential confounding factors were more likely to be identified than if such familiarity had not existed. Confounding in this longitudinal study was controlled by confirming that these factors remained constant throughout the study period and, where they changed, to control their effect by excluding the affected data from the analysis.

One of the most obvious potential confounds for output performance (though not quality) was that performance might have increased simply because demand for the product had increased, rather than because the manager had solved problems. However, the plant did not change its production target for output throughout the study period which was always based on 220 tonnes per day (surplus production of the product—a commodity plastic—was always able to be sold on the spot market).

Other potential confounds which were examined included changes to plant management and workforce, the range of products that was produced, the markets that were served, the technology which was used and whether any major capital investments had been made. Also periodic shut-downs for statutory maintenance and inspection purposes and for installing capital equipment could also have affected the results. Confirmation that these factors did not change over the study period was based on information obtained from company documents, interviews with managers and personal knowledge about the plant.⁴

However, there was one confounding factor that did need to be controlled and, arguably, was only identified because the researcher was familiar with the plant. This confound related to five weeks of data where experimental work was carried out in the plant to develop new grades of product. During these five weeks, performance was much lower and more variable than normal, consequently, the data covering these periods was excluded from the analysis.⁵

In conclusion, the results from the longitudinal study support the hypothesis and indicate that performance improved after the change was made. However, to examine whether the effect of correlating problems with potential causes is associated with higher performance across a wider sample of organizations, a cross-sectional study was subsequently conducted.

3. Cross-sectional study

The longitudinal study has particular strengths, such as being able to measure performance more objectively than the self-rated measures commonly used in management accounting research. However, it also has several weaknesses such as the

control over confounding factors and the limited generalizability of the results. These weaknesses are partly overcome by a cross-sectional study that also provides convergent validity for the studies.

In the longitudinal study, the purpose was to examine whether the increase in the number of ways problems were correlated against potential causes was associated with any change in the performance of the production department. The purpose of the cross-sectional study was to examine whether this relationship existed for different managers in different organizations.

3.1. Sampling and data collection

Operations and production managers at a departmental level from a variety of medium to large manufacturing organizations were sampled because management accounting systems are most likely to be well developed and extensively used in those organizations (Merchant, 1984). Twenty of the 28 organizations randomly sampled from a commercial directory agreed to participate in the study giving a response rate of 71%. All the managers approached within these organizations agreed to participate which resulted in a sample of 47 managers (nine of whom were used in the pilot study and 38 managers formed the basis of the final study). This sample size is similar to studies that have used a comparable method (Gordon & Narayanan, 1984; Otley, 1978).

Face-to-face interviews were considered the most appropriate medium to gather the data because previous studies (e.g. Dew & Gee, 1973) have highlighted difficulties in focusing a manager's attention on constructs associated with organizational feedback. This difficulty was also experienced in the pilot study and reaffirmed the decision to use face-to-face interviews.

The interviews were semi-structured where managers were asked both open-ended and closed questions. The preliminary questions were open-ended and focused on understanding what the goals of the production department were and what feedback was received about those goals. The open-ended questions ensured that a manager was focused on the construct and face-to-face interviews enabled the questions to be repeated until such a

⁴ For example, changes to staff were analyzed comparing names in the internal telephone directory before and after the change. Over the study period only one of the five members of the management team had left.

⁵ Note that three of the five weeks occurred after the change to variance analysis was made and, if this data were included, the results would have been less significant although still significant at the 5% level.

focus was achieved. Closed questions were then asked which quantified the construct (on Likert-type scales) and asking additional open questions subsequently validated responses to these closed questions. Any inconsistencies in the answers could be pursued further and managers often provided additional evidence, such as printed company reports, to validate their responses.

3.2. Operationalizing the independent variable: retaining and analyzing information about problems

The independent variable related to the number of ways problems could be correlated against potential causes and there were three sets of questions that quantified this construct.

The first set of questions (questions 1.1 & 1.2) asked managers about the *actual* information they had about problems. This information was likely to be situation specific and consequently the prescribed alternatives presented to managers in the closed question (which quantified the construct) might not fully reflect a manager's particular situation. This potential problem was managed in two ways.

First, the alternatives in the closed question were made as comprehensive as possible. While the alternatives were initially based on the ways problems were summarized in the longitudinal study, these were supplemented by reviewing the literature for other ways to summarize problems that were likely to be relevant across different organizations. For example, summarizing problems by shift and by location within the factory have both been noted as important by Bruns and McKinnon (1993, p. 96) and Ishakawa (1972), respectively. The alternatives selected were then pilot tested to ensure they were comprehensive.

Second, the interview was designed to ensure that managers' responses fully reflected their situation. The first question (question 1.1) was open-ended and asked managers about how information about problems was analyzed. This free ranging discussion made answering the subsequent closed question (question 1.2) largely a process of formalizing that discussion. However, if that discussion identified other ways (that managers

summarized problems that were not included in the prescribed alternatives), they were treated as a valid response.

The first set of questions asked an open question about the manager's actual information:

Question 1.1 Investigating variances can produce a lot of information about problems. To what extent do you retain and analyse this information over time?

Discussion was then allowed to flow, followed by a closed question which provided the manager with six alternatives:

Question 1.2: Which of the following answers reflect the extent to which information about problems is retained and analysed.

1. No records about specific problems are kept;
2. The prime entry about specific problems is kept (for example, on a supervisor's daily production sheets);
3. Information can be summarized about where in the plant specific problems occurred;
4. Information can be summarized about when specific problems occurred;
5. Information can be summarized about what specific problems occurred for each shift;
6. Information can be summarized about what specific problems occurred when making particular products;

This question was *cumulatively* scored by allocating a point (each alternative was given equal weighting) for each of the manager's responses from (2) to (6). Consequently, a manager who said that they kept a record of the problems (one point) and summarized them by product (one point) and by shift (one point) would receive a total score of three. Thus, the more ways problems were summarized the higher the score.⁶

⁶ To enhance convergent validity with the longitudinal study, question 1.2 also served to validate the operationalization of the independent variable in the longitudinal study. Question 1.2 was used to rate the information before and after the change that was made in the longitudinal study and a higher score is indicated after the change than before, providing support that the same construct was being tapped in both studies.

The second and third sets of questions were based on the manager's *perceptions* about problems. A manager's perception is likely to be based, at least partially, on the actual information available to the manager. Consequently, the second and third sets of questions asked the manager about the ease or difficulty in detecting patterns between problems and tracking problems over time. Managers who stated that it was easily achievable were expected to be managers whose score for question 1.2 was high.

The second and third set of questions asked:

Question 2.1: With your information systems, how difficult or easy is it to tell whether a problem is systematic or random?

Question 3.1: With your information systems, to what extent can problems which recur be tracked over time? For example, is it easy or difficult to see if a problem is improving or getting worse?

For each question, managers were asked to respond to one of five alternatives that were:

(1) very difficult; (2) relatively difficult; (3) not easy but not difficult; (4) relatively easy; (5) very easy.

After each of the above closed questions, a further open question was asked that sought to validate why the manager's answer was easy (or difficult). The manager was asked:

Question 2.2: Why is it easy (difficult) to identify systematic problems?

Question 3.2: Why is it easy (difficult) to track problems over time?

Typically, managers gave an example or showed an internal company report that showed how problems could be identified as systematic or tracked over time. Again, if this validation was inconsistent with previous answers further probing was possible to enhance the validity of the responses.

The three closed questions (questions 1.2; 2.1 & 3.1) measured the independent variable and was

scored by averaging the score for those three questions. These questions were significantly correlated with each other (one of the three inter-correlations was $r = 0.55$ and the other two were $r = 0.70$) and the reliability of the three item instrument was checked by calculating Cronbach's alpha which was an acceptable 0.85. To support the Cronbach alpha, the instrument was also subjected to a factor analysis where the three questions loaded onto one factor with an eigenvalue above 1.0 (eigenvalue of the single factor was 2.3).

3.3. *Dependent variable: performance*

At the end of the interview, performance was operationalised by using a self-rated questionnaire that measured performance in terms of the manager's ability to identify problems associated with important outcomes (such as productivity, quality, customer service).⁷

The performance question was asked for each goal the manager identified during the preliminary part of the interview and weighted by the manager in order to take account of the importance of each outcome (Abernethy & Stoelwinder, 1991; Steers, 1975). The following question was repeated for each outcome:

How would you rate your performance in terms of solving problems associated with _____ (the researcher filled the blank space with the outcome provided by the manager earlier in the interview, eg. productivity, quality, customer service, etc.).

The performance rating was scored on a seven point scale ranging from 'Well above average' (scored as seven) to 'Well below average' (scored as one), weighted by the importance of each goal and a single figure obtained. Confidence that the self-rating performance measures were valid measures of the performance construct was provided in two ways. First, a single item measure of overall

⁷ The Mahoney et al. (1965) measure of performance is probably the most common measure in management accounting studies but it was not suitable here because it focuses on processes (e.g. the ability to plan and co-ordinate), not outcomes such as solving problems.

performance was also asked of managers which was significantly correlated to the question above and this indicated that problem solving was an important component of the manager's job. (The results of the study were essentially the same whether the overall or weighted measures were used.) Secondly, the responses were significantly correlated with superiors' ratings at the 10% level of significance. However, this validation was only possible with the data generated from the pilot study where it was possible to identify the superior.⁸

3.4. *Data analysis and results*

The data for the sample were collected and processed and the results for the descriptive statistics are given below in Table 2.

The hypothesis was tested by correlating the independent variable (a combined score for the three closed questions) with performance and the correlation was positive and highly significant ($r^2 = 0.44$; $t = 5.32$; $p = 0.000$) which provided support for the hypothesis.

4. Discussion, conclusion and future research

This study examined a change to variance analysis in the production department of a manufacturing company where instead of discarding information about problems after they had been explained to the superior, they were retained on a database and subsequently summarized across a number of potential causes. This change was associated with an improvement in performance in the longitudinal study and greater confidence that this change to variance analysis was associated with improved performance was provided by the cross-sectional study.

However, while these empirical results may be interesting, they represent an exploratory area of

research which ultimately needs to be grounded in theory. To this end a number of different, but related, theories are now outlined. The theories are related because the underlying notion of each is similar; that is, where an individual can meaningfully structure information so that relationships between problems and potential causes can be more easily identified, an individual's judgement and problem solving performance will improve.

The first theory is attribution theory (Kelley & Michela, 1980) which originated from psychology but has been used across many disciplines including accounting (e.g. Shields, Birnberg & Frieze, 1981). Applied to problem solving, attribution theory examines how individuals attribute the causes of problems and, in particular, the role of information in this process. In brief, if information about a problem highlights that it is correlated to a potential cause, the relationship is described as distinctive, and the longer this relationship is observed, the more likely the manager will perceive the potential cause as the actual cause.

The second theory relates to social judgement theory (Hammond, Stewart, Brehmer & Stienmann, 1986) where problems are described as "surface" effects because they represent how problems become visible in the work place. In contrast, causes of problems are described as "depth" effects in that they are often less visible, but they represent the underlying causes of the problems. Understanding relationships between problems ("surface" effects) and causes ("depth" conditions) is argued to be important in being able to solve problems.

Both of the above theories are also related to signal detection theory and the theory of diagnostic inference. Signal detection theory relates to a manager's ability to detect patterns or "signals" in data when there is background interference or "noise" (Swets & Pickett, 1982, p.2) and the theory of diagnostic inference which refers to a manager's ability to differentiate between the strength of potential causal relationships ("signals") and the strength of alternative causal relationships ("noise") (Brown, 1985).

However, much more theoretical development needs to be undertaken to build theories that provide us with a better understanding of problem

⁸ Corroboration of performance from superiors was possible in the pilot study because access to the managers was gained via the Finance Director and the manager's superior. However, this approach was time consuming and for the main study the managers were approached directly where the manager's superior was not identified.

Table 2
Descriptive statistics

Characteristics	Actual			Theoretical			
	Mean	Median	Std dev	Min	Max	Min	Max
<i>Independent variable</i>							
Question 1	2.93	3.00	1.07	1.00	5.00	1.00	5.00
Question 2	3.04	3.00	1.17	1.00	5.00	1.00	5.00
Question 3	2.81	3.00	1.04	1.00	5.00	1.00	5.00
Combined score questions 1–3	2.93	3.00	0.96	1.00	5.00	1.00	5.00
<i>Dependent variable</i>							
Performance	4.95	5.15	1.21	1.70	7.00	1.00	7.00

solving in organizations and to be comprehensive such theories would need to be integrated with theories of learning which, arguably, provided the intervening mechanism to performance in this study.

Finally, the results of this study need to be qualified by highlighting the limitations of the study. The first limitation concerns the nature of problem solving for managers in different situations. For example, the premise underlying this study is that managers can learn from past mistakes but where managers operate in highly uncertain environments, learning from past mistakes may be of little help in solving future problems. Also the study focused on problem solving at a departmental level and a different approach to solving problems may be necessary at higher levels of organizations.

The second limitation concerns whether it is only managers with sufficient slack resources that can afford the time and resources to devote to the sort of information gathering and analyzing exercise that has been described in this study. That is, managers who are continually fire-fighting problems are unable to conduct this sort of reflective analysis and this leads to the possibility of reverse causality. In other words, higher performing managers may be those that can generate sufficient slack resources to conduct this sort of analysis and thus more likely to be higher performers in the future.

Overcoming these limitations requires future research to specifically address these issues but this study has provided the basis to motivate such research.

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References

- Abernethy, M. A., & Stoelwinder, J. U. (1994). Budget use, task uncertainty, system goal orientation and subunit performance: a test of the 'fit' hypothesis in not-for-profit hospitals. *Accounting, Organizations and Society*, 16(2), 105–120.
- Birnberg, J. G., Shields, M. D., & Young, S. M. (1990). The case for multiple methods in empirical management accounting research. *Journal of Management Accounting Research*, 2, 33–66.
- Brown, C. (1985). Causal reasoning in performance assessment: effects of cause and effect, temporal order and covariation. *Accounting, Organizations and Society*, 10(3), 255–266.
- Bruns, W. J., & McKinnon, S. M. (1993). Information and managers: a field study. *Journal of Management Accounting Research*, 5, 84–108.
- Cronbach, L. J. (1970). *The essentials of psychological testing*. Harper and Row.
- Dew, R. and Gee, K. (1973). *Management control information*. Macmillan.
- Feldman, M. S. & March, J. G. (1981). Information in organization as signal and symbol. *Administrative Science Quarterly*, 171–186.

- Gordon, L. A., & Narayanan, V. K. (1984). Management accounting systems, perceived environmental uncertainty and organizational structure: An empirical investigation. *Accounting, Organizations and Society*, 9(1), 33–47.
- Hammond, K. R., Stewart, T. R., Brehmer, B. & Steinmann, D. O. (1986). Social judgement theory. In H. R. Arkes & K. R. Hammond (Eds.) *Judgment and decision making: an interdisciplinary reader*. Cambridge University Press.
- Horngren, C. T., & Foster, G. (1991). *Cost accounting: a managerial emphasis*. Englewood Cliffs, NJ: Prentice-Hall.
- Ishakawa. (1972). *Guide to quality control*. Asian Productivity Organization.
- Kelley, H. H., & Michela, J. L. (1980). Attribution theory and research. *Annual Review of Psychology*, 31, 457–501.
- Kopelman, R. E. (1986). Objective feedback. In E. A. Locke, (Ed.), *Generalising from the laboratory to field settings*. Lexington Books.
- Locke, E. A., Smith, K. G., Erex, M., Chah, D., & Schaffer, A. (1994). The effects of intra-individual goal conflict on performance. *Journal of Management*, 20(1), 67–91.
- Luckett, P. F., & Eggleton, I. R. C. (1991). Feedback and management accounting: A review of research into behavioral consequences. *Accounting, Organizations and Society*, 16(4), 371–394.
- Mahoney, T. A., Jerdee, T. S., & Carroll, S. J. (1965). The jobs of management. *Industrial Relations*, (February), 105–120.
- Merchant, K. A. (1984). Influences on departmental budgeting: an empirical examination of a contingency model. *Accounting, Organizations and Society*, 9(3/4), 291–307.
- Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.
- Otley, D. T. (1978). Budget use and managerial performance. *Journal of Accounting Research*, 16(1), 122–149.
- Shields, M. D., Birnberg, J. G., & Frieze, I. H. (1981). Attributions, cognitive processes and control systems. *Accounting, Organizations and Society*, 6(1), 69–93.
- Simon, H. A. (1957). *Models of man*. New York: Wiley.
- Steers, R. M. (1975). Problems in the measurement of organizational effectiveness. *Administrative Science Quarterly*, 546–558.
- Swets, J. A. & Pickett, R. M. (1982). *Evaluation of diagnostic systems*. Academic Press.