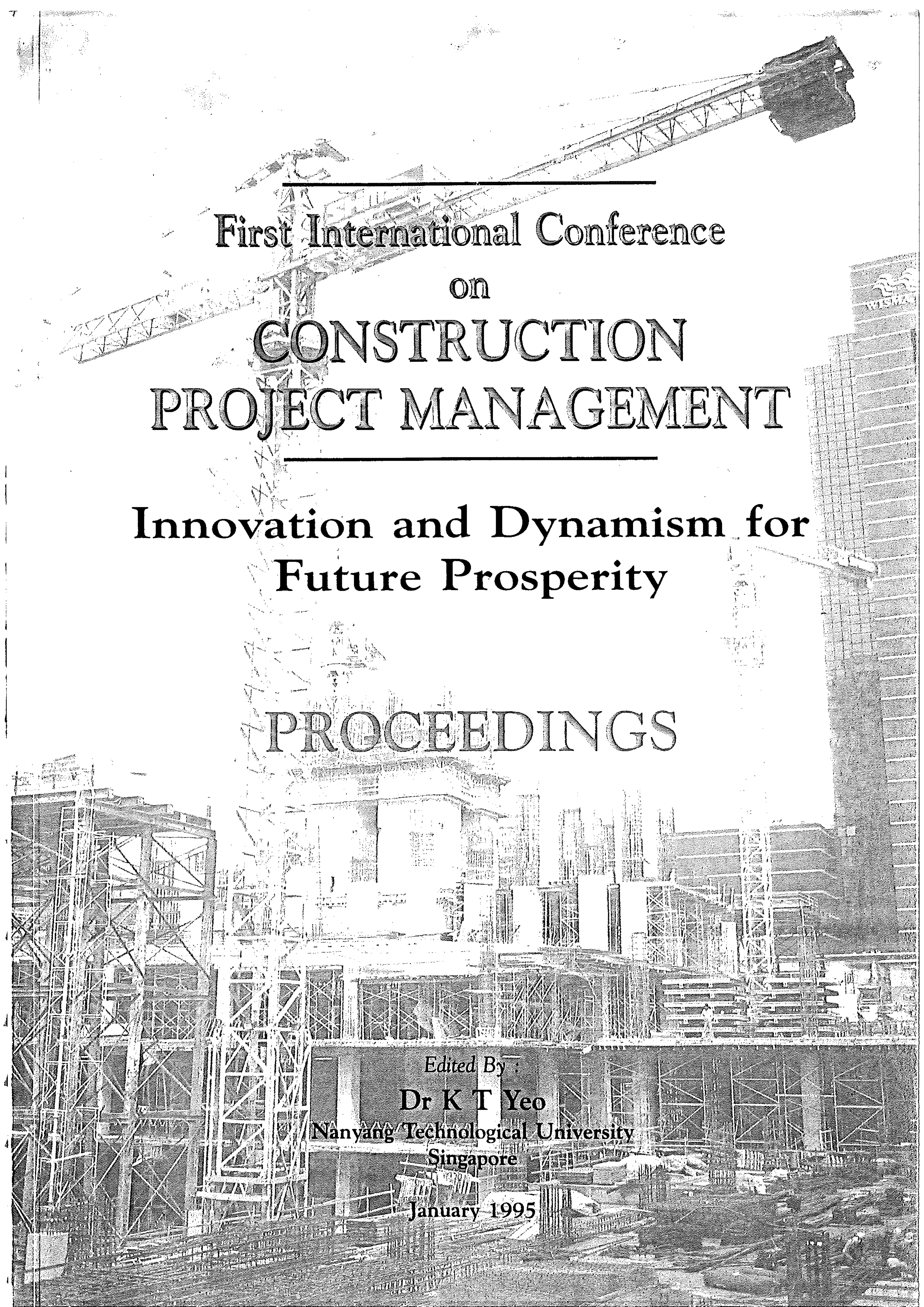
Transformed financial ratio models for improved contractor evaluation



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TRANSFORMED FINANCIAL RATIO MODELS FOR IMPROVED CONTRACTOR EVALUATION

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ABSTRACT

The application of financial ratio models for contractor evaluation has been used to provide an overall perspective of a contractor's potential for failure, and to serve as a basis for the contractor's strategic planning. The poor performance of such models has prompted concern over their suitability for such evaluations. The inefficiency of ratio models has been associated with two factors: data quality for model estimation; and the range of classifications that the models can achieve. Analysis with thirty-three basic ratio samples showed that most ratios do not conform to the normality condition required to satisfy the technique for their estimation. Two transformation approaches are proposed to enhance the data quality and to expand the classification range for developing improved ratio models.

INTRODUCTION

The construction industry's need for effective contractor evaluation utilising a financial-based analysis cannot be overemphasised. Such an evaluation can serve as a background to their strategic planning. Client bodies can also exploit such evaluations in conjunction with conventional project-oriented criteria as a more suitable method of selecting a contractor at the tender stage.

The construction industry experiences a high rate of bankruptcy [HMSO 1993]. The cause of such failures can be associated in many cases with a lack of strategic planning. Schleifer [1990] commented that long-term strategies, and strategic planning are not addressed in any formal way by many construction contractors. In a market place where there is an escalation of competition due to rapid changes within the national and global contexts [Betts & Ofori 1993], a lack of strategic planning by contractors had resulted in record levels of corporate collapse, especially with the impact of the recession that started in 1989 [Thorpe & McCaffer 1991]. However, the situation is changing, with several medium and large construction contractors adopting strategic planning to ensure their continued survival. The financial evaluation which usually forms a significant part of such planning is performed by ratio analysis. A recent achievement in the application of such ratios is the development of financial ratio models. These models provide a single index that dichotomises between financially sound, and potential bankrupt companies. Such information can provide guidance on the selection of appropriate strategies to address the company's future.

The reliability of models used in such evaluation has, however, been brought into question. Inman [1991] for instance outlined six cases in which evaluation with both the models of Altman [1983], and Taffler [1983] produced contradictory results. Langford et al. [1993], in a similar exercise showed that for the construction industry, the model of Mason & Harris [1979] was not infallible. Karels & Prakash [1987] argued that the reliability of the models employed for such evaluation relate to the quality of the data employed in their modelling, as well as the theoretical assumptions which forms the basis of their application.

This paper forms part of a study on strategic planning within construction contracting organisations, and addresses the reliability of the models employed for the financial evaluation involved. This is achieved by investigating the two aspects of data quality and the underlying theoretical assumption of the models. Improvements in both aspects are examined utilising transformations.

FINANCIAL EVALUATION OF CONTRACTORS

Although financial evaluation encompasses several analyses (including ratios, sources and application of funds, and break-even investigations) ratio analysis enjoys the greatest popularity. This is attributable to the provision of relevant and important information, which serves as the basis for a sound decision-making process at various levels both within and outwith an organisation. When properly analysed, ratios provide both past and current information on an organisation's operations, performance, and financial position. They serve as a planning basis to project future trends, which provide the management of a construction business with a comparative means for assessing any future variances in the company's profile.

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Ratio models combine a number of single ratios in a multivariate analysis to establish mathematical relationships for evaluating the financial stability of a company. This allows a more thorough evaluation of a company's performance and potential for survival as a going concern, to be performed in a single computation. The application of the ratio model approach has been of considerable interest to researchers in both general business [Altman 1983; Taffler

1983; Keasey & Watson 1986], and the construction sector alike [Mason & Harris 1979; Abidali 1990; Russell & Jaselski 1992; Langford et al. 1993]. Mason & Harris [1979], Abidali [1990] and Langford et al. [1993], go a step further and recommend the application of the ratio models for contractor evaluation by the client at the tender stage.

Most of the work into the application of ratio modelling relates to the prediction of company failure. The potential of failure serves as an indication of the risk involved in engaging the services of the company concerned, with greater failure potential implying greater risk. For instance, Altman [1983] used a multivariate analysis approach and established a corporate failure prediction model. His model, initially developed in 1968, was achieved by means of a multiple discriminant analysis of twenty-two potential financial ratio variables. These were identified from previous studies. The main idea was the combination of several weighted financial ratios to provide a single index (known as a Z-score), that classified a business as failing, or non-failing. The results of his analysis produced the following composite model:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \qquad \text{Eqn(1)}$$

X_1 = working capital / total assets

X_2 = retained earnings since inception / total assets;

X_3 = earnings before taxes and interest / total assets;

X_4 = market value of equity / book value of total debt; and

X_5 = turnover / total assets.

A similar exercise was performed for evaluating construction organisations by Mason and Harris [1979], and later by Abidali [1990]. A six variable model, equation (2) was produced by Mason and Harris, whilst the analysis of Abidali resulted in a seven variable model equation (3).

$$Z = 25.4 - 51.2X_1 + 87.8X_2 - 4.8X_3 - 14.5X_4 - 9.1X_5 - 4.5X_6 \qquad \text{Eqn(2)}$$

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$$Z = 14.60 + 82.00X_1 - 14.50X_2 + 2.50X_3 - 1.20X_4 + 3.55X_5 - 3.55X_6 - 3.00X_7 \qquad \text{Eqn(3)}$$

where:

X_1 = profit after tax and interest / net capital employed;

X_2 = current assets / net assets;

X_3 = turnover / net assets;

X_4 = short term loans /profit before tax and interest;

X_5 = tax trend;

X_6 = profit after tax trend; and

X_7 = short term loan trend.

Altman's model incorporates five ratios that reflect the different categories of the traditional ratio measures for assessing companies. A period of two years was acknowledged as the time within which his model would produce reliable and accurate forecasts. It was expected that the prediction of companies that are liable to failure within such time setting could be achieved with considerable accuracy. However, analysis performed by Inman[1991] does not confirm such accuracy. Both Mason & Harris [1979], and Abidali [1990] tried to improve upon the performance of Altman's ratio model. This was achieved by incorporating some trend measures with the basic ratios within a single discriminant equation. Analysis by Langford et al. [1993] using the model of Mason & Harris [1979], showed that the model cannot be described as infallible. The use of such models for construction contractor evaluation can result in misleading information. If they are used as a basis for effective contractor evaluation, which is to provide a basis for strategic planning, then the models need to be improved to provide an efficient evaluation.

LIMITATION OF RATIO MODELS

Data quality for model development

Ratio models are generally constructed by the technique of multi-discriminant analysis. The fundamental assumption of this technique is that the independent variables or attributes employed in estimating the models are characterised by a normal distribution. Significant violation of this assumption can result in an inefficient model. There is no evidence from previous model developers regarding this condition for their data. As such, it would appear that ratio models have been constructed assuming normality for the data used in their estimation. This assumption has been shown to be unreliable [Karels & Prakash 1987]. The condition of normality is essential for the consistent application of the multi-discriminant technique. Thus, the normality of the attributes needs to be investigated to ensure that the models are constructed with normal or near-normal variables.

Range of classification with ratio models

An additional limitation of existing ratio models is the use of a single "two option" approach to the evaluation of construction companies. This is typified by the use of "bankrupt" or "healthy" to represent their financial condition. Such an approach is overly simple, and unlikely to capture the spectrum of different conditions that the construction company may experience. Contractors are not simply bankrupt or healthy, but rather exhibit different degrees of financial security or distress that change in severity from period to period. The underlying process that leads to failure cannot therefore be adequately represented by such a single dichotomous equation. The need to expand the scope of the classification within the evaluation model, and capture the wider spectrum of financial conditions that contractors are likely to experience, becomes apparent. Such a wider scope for evaluation will be more responsive to of strategic planning requirements.

INVESTIGATING NORMALITY OF RATIO ATTRIBUTES

The Shapiro-Wilk (W) test was chosen to test the normality of the ratio attributes. This test has been shown to be an effective procedure for evaluating the assumption of normality against a wide spectrum of non-normal alternatives [Hahn & Shapiro 1967]. In a study of the comparative sensitivities of nine different tests for normality, including the chi-squared and the W-test, Shapiro et al. [1968] established that the W-test provides a superior indicator of non-normality, judged over the other various symmetric, asymmetric, short- and long-tailed alternatives. The chi-squared test for normality was not employed in this case, for the reason that the chi-squared procedure relies on the population parameters being known. The usual practice is to use the sample mean and variance as the 'true' estimates of their population counterparts. The possibility of mis-specification due to estimation of the population parameters, from a sample which does not give the most likely estimates, can influence the outcome of the analysis. Financial data, the population from which the samples are drawn for the analysis, can be described as continuous or infinite. Hence, its population parameters are 'unknown', and the chi-squared test cannot be considered the most appropriate method for testing normality of such data. The W-test does not depend on the population parameters being known, and is therefore considered more suitable. Additionally, the W-test is scale and origin invariant, and so eliminates the problem of accepting a biased sample.

The W procedure tests the null hypothesis	$\mathbf{H_0}$:	the parent population is normal
against the alternative	$\mathbf{H_1}$:	the parent population is not normal.

Following the recommendation of Hahn & Shapiro [1967], basic ratio samples that produced W-values greater than or equal to 50 per cent were regarded as providing reasonable evidence for the assumption of a normal distribution of the population. This provided for a minimum W-value of 0.9586. The null hypothesis was accepted for the ratio samples for which W-values equalled or exceeded the minimum. Otherwise, the alternative hypothesis was accepted for that financial ratio variable.

Transformation of ratio attributes

In many applications of statistical theory, it is necessary to change the form of a given random variable in order to facilitate an appropriate solution. Such a transformation ensures that the random variable conforms to some desired distribution characteristics. Investigations with several mathematical transformations were conducted on the various samples. This indicated that logarithmic, inverse and various power transformations were most suitable for improving the normality of the data.

RANGE OF CLASSIFICATION

Statistical transformations were also investigated for improving the range of classifications for the models. The different conditions of the contractor's financial profile can be characterised by phases [Laitenen 1993]. These were distinguished by the use of different statistical transformations as follows:

- **a financially solvent phase**
  characterised by an improvement in or maintenance of previous financial ratios which are above industry averages;
- **an initial distress phase**
  characterised by a partial collapse of financial ratios, but then the level of the ratios will be high enough not to reveal a potential for corporate failure, but annual differences of the ratios will show the anomaly;
- **an intervening phase**
  a reaction to the initial distress phase, resulting in a slow down of the decline in the financial ratios, this may show as an improvement, however, the trend or average over a number of years will reveal the real situation of the company; and
- **a final phase**
  characterised by a decline to a poor level of performance (which is often captured by most conventional ratio models), revealed in the poor levels of the basic ratios.

Ratio selection

Thirty-three ratios were selected for the analysis and employed subsequently used in developing the improved ratio models. These were based on the previously developed models of Altman, Taffler, Mason & Harris, and Abidali, as well as other popular ratios that are featured in financial analyses. The selected ratios reflected the various category measures of the traditional ratios measures.

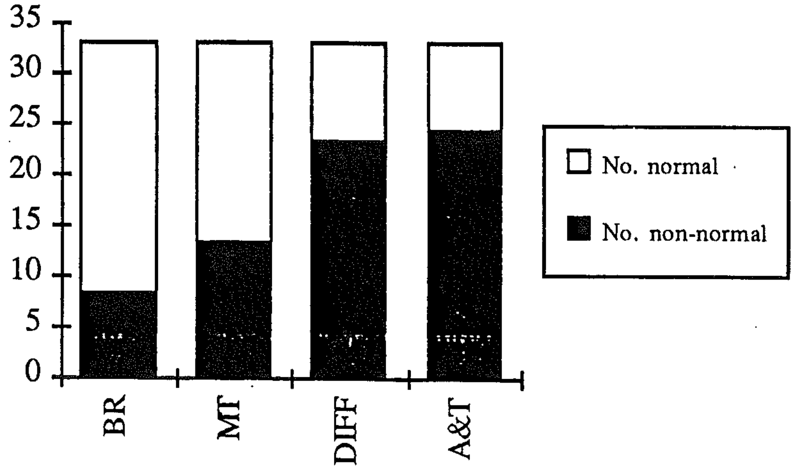
Sample composition

A pool of eighty construction companies, with a significant proportion of their operations in contracting, was obtained from the database FAME: Financial Analysis Made Easy [Jordan & Sons 1993, 1994]. The database supplied company reports and financial accounts over a five-year period which were annually updated. All companies listed in the database had the most recent records of their published reports and financial accounts for the last five years up to the year of updating.

Forty companies were randomly chosen to provide the selected financial ratios from 1988 to 1992, inclusive. If data required for the computation of a particular ratio for a drawn company were not available, that company was substituted by the next randomly drawn company.

RESULTS OF NORMALITY TEST FOR THE SAMPLES

Table 1 presents ratio samples which yielded W-values greater than 0.9586, and for which the null hypothesis was accepted. Table 2 presents ratios exhibiting non-normality after transformations. About twenty-five per cent of the basic ratios tested exhibited evidence of normality. Figure 1 presents the comparative improvement in the number of basic ratio samples after subjecting them to the transformations.



BR - Basic Ratios
MT - Mathematical Transformed Ratios
DIFF - Annual Differences of Ratios
A&T - Three-year Averages and Trends

Figure 1. Ratio samples exhibiting normality for the various sample categories.

Table 1. Ratio Samples Characterised by Normality

Basic Ratios	Current Ratio, Solvency Ratio, Net Worth to Total Assets, Total Liability to Total Assets, Reserves to Total Assets, Gross Profit to Sales, Total Asset Turnover, Credit period.
Mathematical Transformed Ratios	***Log normal*** Collection period ***Power*** Liquidity Ratio, Stock to Current Assets, Debt to Equity, Non-current Liability to Total Assets, Net Worth to Total Liability, Fixed Assets to Total Assets, Working Capital to Sales, Return on Capital Employed, Profit to Total Assets, Sales to Net Worth, Net Assets Turnover, Credit Period.
Statistical Transformed Ratios	***Differences*** Current Ratio, Liquidity Ratio, Stock to Current Assets, Shareholder Liquidity Ratio, Solvency Ratio, Gearing, Non-Current Liability to Total Assets, Non-Current Liability to Capital Employed, Net Worth to Total Liability, Net Worth to Total Assets, Total Liability to Total Assets, Net Worth to Fixed Assets, Reserves to Total Assets, Fixed Assets to Total Assets, Current Assets to Fixed Assets, Working Capital to Total Assets, Working Capital to Sales, Profit to Net Worth, Return on Capital Employed, Profit to Total Assets, Sales to Net Worth, Stock Turnover, Total Asset Turnover, Interest Cover. ***Three-year Average and Trend*** Current Ratio, Liquidity Ratio, Stock to Current Assets, Shareholder Liquidity Ratio, Solvency Ratio, Gearing, Net Worth to Total Liability, Net Worth to Total Assets, Total Liability to Total Assets, Net Worth to Fixed Assets, Reserves to Total Assets, Fixed Assets to Total Assets, Working Capital to Total Assets, Working Capital to Sales, Profit to Net Worth, Profit to Total Assets, Profit to Sales, Stock Turnover, Debtors Turnover, Sales to Net Worth, Total Assets Turnover, Credit Period, Collection Period.

Table 2. Ratios Exhibiting Non-Normality After Transformation

Mathematical Transformed	Shareholder Liquidity, Gearing, Non current Liability to Capital Employed, Net Worth to Fixed Assets, Current Assets to Fixed Assets, Current Assets to Net Worth, Profit to Net Worth, Profit to Total Assets, Stock Turnover, Debtors Turnover, Fixed Assets Turnover, Interest Cover.
Statistical Transformed	Current Assets to Net Worth, Net Assets Turnover, Fixed Assets Turnover.

DISCUSSION

The result of the normality test on the basic ratios showed that two of the five attributes making up Altman's model (Retained Earnings or Reserves to Total Assets, and Turnover to Total Assets or Total Assets Turnover), conformed to the requirements of normality. The other three attributes, when subjected to mathematical transformation, produced near normal distributions. Equally, two attributes from the Mason & Harris model displayed consistent normality. Only one basic ratio attribute from the Abidali model exhibited normality. The inability of the attributes to conform to the requirements of normality explains the inadequacy of the models to provide consistent and efficient performance. There was very limited scope for utilising the log normal transformation to improve the data, as financial ratios often take on negative values.

Statistical transformations resulted in significant improvement in the normality of the attributes, and produced ratio variables in all the five categories of the traditional ratios. This proved superior because of the smoothening effect the statistical transforms attains. In particular, all the attributes in the Altman model were characterised by normality when various samples were subjected to the statistical transformations. The statistical transformed ratios reflect a wider spectrum of conditions that construction contractors are likely to experience. Consequently, they can be employed to provide a more effective classification between the different phases of a contractor's financial profile.

The basic financial ratios that satisfied the conditions of normality were ones that generally did not feature in the models of Altman, Mason & Harris, and Abidali. This preliminary evidence could explain the inefficiency of the models. It is proposed that the predictive efficiency of discriminant models could be improved considerably by developing them with the normal and transformed normal attributes. The next stage of the work addresses the development of such a model. The concept of different phases of a contractor's financial profile will be employed in developing a sequential model with the discriminant technique. The sequential approach will utilise the normal and transformed normal attributes to produce a three-equation model of the form shown below.

Z1= discriminant equation of differences, for classifying between a sound financial phase and the initial distress phase;
Z2= discriminant equation of trends or three-year averages, for classifying between the initial distress phase and the intervening phase; and
Z3= discriminant equation of basic ratios, classify between the intervening phase and a potential imminent failure.

CONCLUSION

This paper has examined two major considerations relating to the development of financial ratio models. The lack of conformity to the requirements of normality for a significant proportion of the attributes contained in the models, partly explains their inability to perform efficiently. The application of mathematical and statistical transformations improves the normality of a number of the ratio variables, and should enhance the technique of the modelling process.

Secondly, a dichotomous classification of existing ratio models does not provide a wide range to reflect the different financial profiles that contractors can experience. The use of a sequential model based on the four phase financial profile presented provides greater scope for a more accurate evaluation.

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X_3 = turnover / net assets;

X_4 = short term loans /profit before tax and interest;

X_5 = tax trend;

X_6 = profit after tax trend; and

X_7 = short term loan trend.

Altman's model incorporates five ratios that reflect the different categories of the traditional ratio measures for assessing companies. A period of two years was acknowledged as the time within which his model would produce reliable and accurate forecasts. It was expected that the prediction of companies that are liable to failure within such time setting could be achieved with considerable accuracy. However, analysis performed by Inman[1991] does not confirm such accuracy. Both Mason & Harris [1979], and Abidali [1990] tried to improve upon the performance of Altman's ratio model. This was achieved by incorporating some trend measures with the basic ratios within a single discriminant equation. Analysis by Langford et al. [1993] using the model of Mason & Harris [1979], showed that the model cannot be described as infallible. The use of such models for construction contractor evaluation can result in misleading information. If they are used as a basis for effective contractor evaluation, which is to provide a basis for strategic planning, then the models need to be improved to provide an efficient evaluation.

LIMITATION OF RATIO MODELS

Data quality for model development

Ratio models are generally constructed by the technique of multi-discriminant analysis. The fundamental assumption of this technique is that the independent variables or attributes employed in estimating the models are characterised by a normal distribution. Significant violation of this assumption can result in an inefficient model. There is no evidence from previous model developers regarding this condition for their data. As such, it would appear that ratio models have been constructed assuming normality for the data used in their estimation. This assumption has been shown to be unreliable [Karels & Prakash 1987]. The condition of normality is essential for the consistent application of the multi-discriminant technique. Thus, the normality of the attributes needs to be investigated to ensure that the models are constructed with normal or near-normal variables.

Range of classification with ratio models

An additional limitation of existing ratio models is the use of a single "two option" approach to the evaluation of construction companies. This is typified by the use of "bankrupt" or "healthy" to represent their financial condition. Such an approach is overly simple, and unlikely to capture the spectrum of different conditions that the construction company may experience. Contractors are not simply bankrupt or healthy, but rather exhibit different degrees of financial security or distress that change in severity from period to period. The underlying process that leads to failure cannot therefore be adequately represented by such a single dichotomous equation. The need to expand the scope of the classification within the evaluation model, and capture the wider spectrum of financial conditions that contractors are likely to experience, becomes apparent. Such a wider scope for evaluation will be more responsive to of strategic planning requirements.

INVESTIGATING NORMALITY OF RATIO ATTRIBUTES

The Shapiro-Wilk (W) test was chosen to test the normality of the ratio attributes. This test has been shown to be an effective procedure for evaluating the assumption of normality against a wide spectrum of non-normal alternatives [Hahn & Shapiro 1967]. In a study of the comparative sensitivities of nine different tests for normality, including the chi-squared and the W-test, Shapiro et al. [1968] established that the W-test provides a superior indicator of non-normality, judged over the other various symmetric, asymmetric, short- and long-tailed alternatives. The chi-squared test for normality was not employed in this case, for the reason that the chi-squared procedure relies on the population parameters being known. The usual practice is to use the sample mean and variance as the 'true' estimates of their population counterparts. The possibility of mis-specification due to estimation of the population parameters, from a sample which does not give the most likely estimates, can influence the outcome of the analysis. Financial data, the population from which the samples are drawn for the analysis, can be described as continuous or infinite. Hence, its population parameters are 'unknown', and the chi-squared test cannot be considered the most appropriate method for testing normality of such data. The W-test does not depend on the population parameters being known, and is therefore considered more suitable. Additionally, the W-test is scale and origin invariant, and so eliminates the problem of accepting a biased sample.

The W procedure tests the null hypothesis $\mathbf{H_0}$: the parent population is normal

against the alternative $\mathbf{H_1}$: the parent population is not normal.

Following the recommendation of Hahn & Shapiro [1967], basic ratio samples that produced W-values greater than or equal to 50 per cent were regarded as providing reasonable evidence for the assumption of a normal distribution of the population. This provided for a minimum W-value of 0.9586. The null hypothesis was accepted for the ratio samples for which W-values equalled or exceeded the minimum. Otherwise, the alternative hypothesis was accepted for that financial ratio variable.

Transformation of ratio attributes

In many applications of statistical theory, it is necessary to change the form of a given random variable in order to facilitate an appropriate solution. Such a transformation ensures that the random variable conforms to some desired distribution characteristics. Investigations with several mathematical transformations were conducted on the various samples. This indicated that logarithmic, inverse and various power transformations were most suitable for improving the normality of the data.

RANGE OF CLASSIFICATION

Statistical transformations were also investigated for improving the range of classifications for the models. The different conditions of the contractor's financial profile can be characterised by phases [Laitenen 1993]. These were distinguished by the use of different statistical transformations as follows:

- **a financially solvent phase**
  characterised by an improvement in or maintenance of previous financial ratios which are above industry averages;
- **an initial distress phase**
  characterised by a partial collapse of financial ratios, but then the level of the ratios will be high enough not to reveal a potential for corporate failure, but annual differences of the ratios will show the anomaly;
- **an intervening phase**
  a reaction to the initial distress phase, resulting in a slow down of the decline in the financial ratios, this may show as an improvement, however, the trend or average over a number of years will reveal the real situation of the company; and
- **a final phase**
  characterised by a decline to a poor level of performance (which is often captured by most conventional ratio models), revealed in the poor levels of the basic ratios.

Ratio selection

Thirty-three ratios were selected for the analysis and employed subsequently used in developing the improved ratio models. These were based on the previously developed models of Altman, Taffler, Mason & Harris, and Abidali, as well as other popular ratios that are featured in financial analyses. The selected ratios reflected the various category measures of the traditional ratios measures.

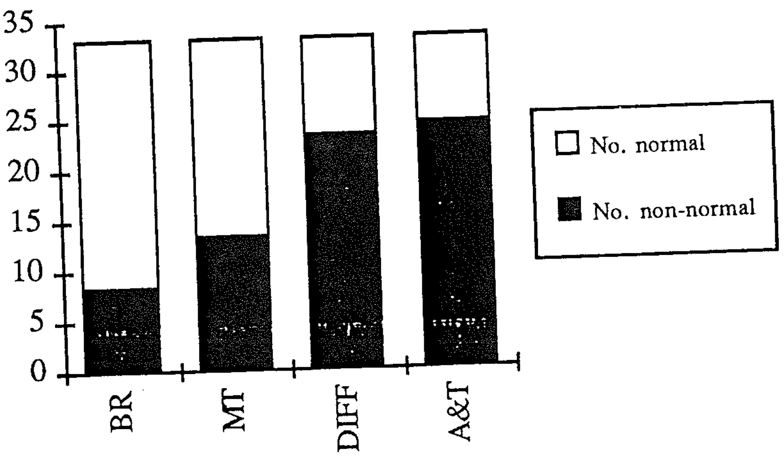
Sample composition

A pool of eighty construction companies, with a significant proportion of their operations in contracting, was obtained from the database FAME: Financial Analysis Made Easy [Jordan & Sons 1993, 1994]. The database supplied company reports and financial accounts over a five-year period which were annually updated. All companies listed in the database had the most recent records of their published reports and financial accounts for the last five years up to the year of updating.

Forty companies were randomly chosen to provide the selected financial ratios from 1988 to 1992, inclusive. If data required for the computation of a particular ratio for a drawn company were not available, that company was substituted by the next randomly drawn company.

RESULTS OF NORMALITY TEST FOR THE SAMPLES

Table 1 presents ratio samples which yielded W-values greater than 0.9586, and for which the null hypothesis was accepted. Table 2 presents ratios exhibiting non-normality after transformations. About twenty-five per cent of the basic ratios tested exhibited evidence of normality. Figure 1 presents the comparative improvement in the number of basic ratio samples after subjecting them to the transformations.



BR - Basic Ratios
MT - Mathematical Transformed Ratios
DIFF - Annual Differences of Ratios
A&T - Three-year Averages and Trends

Figure 1. Ratio samples exhibiting normality for the various sample categories.

Table 1. Ratio Samples Characterised by Normality

Basic Ratios	Current Ratio, Solvency Ratio, Net Worth to Total Assets, Total Liability to Total Assets, Reserves to Total Assets, Gross Profit to Sales, Total Asset Turnover, Credit period.
Mathematical Transformed Ratios	***Log normal*** Collection period ***Power*** Liquidity Ratio, Stock to Current Assets, Debt to Equity, Non-current Liability to Total Assets, Net Worth to Total Liability, Fixed Assets to Total Assets, Working Capital to Sales, Return on Capital Employed, Profit to Total Assets, Sales to Net Worth, Net Assets Turnover, Credit Period.
Statistical Transformed Ratios	***Differences*** Current Ratio, Liquidity Ratio, Stock to Current Assets, Shareholder Liquidity Ratio, Solvency Ratio, Gearing, Non-Current Liability to Total Assets, Non-Current Liability to Capital Employed, Net Worth to Total Liability, Net Worth to Total Assets, Total Liability to Total Assets, Net Worth to Fixed Assets, Reserves to Total Assets, Fixed Assets to Total Assets, Current Assets to Fixed Assets, Working Capital to Total Assets, Working Capital to Sales, Profit to Net Worth, Return on Capital Employed, Profit to Total Assets, Sales to Net Worth, Stock Turnover, Total Asset Turnover, Interest Cover. ***Three-year Average and Trend*** Current Ratio, Liquidity Ratio, Stock to Current Assets, Shareholder Liquidity Ratio, Solvency Ratio, Gearing, Net Worth to Total Liability, Net Worth to Total Assets, Total Liability to Total Assets, Net Worth to Fixed Assets, Reserves to Total Assets, Fixed Assets to Total Assets, Working Capital to Total Assets, Working Capital to Sales, Profit to Net Worth, Profit to Total Assets, Profit to Sales, Stock Turnover, Debtors Turnover, Sales to Net Worth, Total Assets Turnover, Credit Period, Collection Period.

Table 2. Ratios Exhibiting Non-Normality After Transformation

Mathematical Transformed	Shareholder Liquidity, Gearing, Non current Liability to Capital Employed, Net Worth to Fixed Assets, Current Assets to Fixed Assets, Current Assets to Net Worth, Profit to Net Worth, Profit to Total Assets, Stock Turnover, Debtors Turnover, Fixed Assets Turnover, Interest Cover.
Statistical Transformed	Current Assets to Net Worth, Net Assets Turnover, Fixed Assets Turnover.

DISCUSSION

The result of the normality test on the basic ratios showed that two of the five attributes making up Altman's model (Retained Earnings or Reserves to Total Assets, and Turnover to Total Assets or Total Assets Turnover), conformed to the requirements of normality. The other three attributes, when subjected to mathematical transformation, produced near normal distributions. Equally, two attributes from the Mason & Harris model displayed consistent normality. Only one basic ratio attribute from the Abidali model exhibited normality. The inability of the attributes to conform to the requirements of normality explains the inadequacy of the models to provide consistent and efficient performance. There was very limited scope for utilising the log normal transformation to improve the data, as financial ratios often take on negative values.

Statistical transformations resulted in significant improvement in the normality of the attributes, and produced ratio variables in all the five categories of the traditional ratios. This proved superior because of the smoothening effect the statistical transforms attains. In particular, all the attributes in the Altman model were characterised by normality when various samples were subjected to the statistical transformations. The statistical transformed ratios reflect a wider spectrum of conditions that construction contractors are likely to experience. Consequently, they can be employed to provide a more effective classification between the different phases of a contractor's financial profile.

The basic financial ratios that satisfied the conditions of normality were ones that generally did not feature in the models of Altman, Mason & Harris, and Abidali. This preliminary evidence could explain the inefficiency of the models. It is proposed that the predictive efficiency of discriminant models could be improved considerably by developing them with the normal and transformed normal attributes. The next stage of the work addresses the development of such a model. The concept of different phases of a contractor's financial profile will be employed in developing a sequential model with the discriminant technique. The sequential approach will utilise the normal and transformed normal attributes to produce a three-equation model of the form shown below.

Z1= discriminant equation of differences, for classifying between a sound financial phase and the initial distress phase;
Z2= discriminant equation of trends or three-year averages, for classifying between the initial distress phase and the intervening phase; and
Z3= discriminant equation of basic ratios, classify between the intervening phase and a potential imminent failure.

CONCLUSION

This paper has examined two major considerations relating to the development of financial ratio models. The lack of conformity to the requirements of normality for a significant proportion of the attributes contained in the models, partly explains their inability to perform efficiently. The application of mathematical and statistical transformations improves the normality of a number of the ratio variables, and should enhance the technique of the modelling process.

Secondly, a dichotomous classification of existing ratio models does not provide a wide range to reflect the different financial profiles that contractors can experience. The use of a sequential model based on the four phase financial profile presented provides greater scope for a more accurate evaluation.

REFERENCES

Abidali, A.F. (1990). *A methodology for predicting company failure in the construction industry*. PhD thesis submitted to Loughborough University of Technology, England.