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TO WHAT EXTENT CAN THE Z-SCORE MEASURE SYSTEM PERFORMANCE?

Abstract

The Z-score has a rich history of use for analysing companies' financial performance. The composite method was originally developed to predict corporate bankruptcy and remains a favoured statistical technique used by institutional and private investors. Their use of Z-scores is to forecast the likelihood of a company failing in the next year based on its capital structure [history], to predict the company's financial distress or success [future]. Thus, the Z-score serves as a predictor to inform investors' decisions and potentially helps companies make better-informed decisions regarding their governance and capital structure. Having applied Z-score on multiple occasions and supervised its use by countless undergraduates and postgraduates, there is something intuitively appealing about the technique. When reflecting on the many applications of the Z-score, it is argued that the Z-score also measures the macro and micro-operations of companies and their critical service delivery systems. In this paper, we will present the history of the Z-score, demonstrate how the statistical method works, and argue for its relevance in measuring system and operational performance.

Keywords: Capital Structure, operations, performance measurement, systems, and Z-score.

1. Introduction

In Jackson's latest work, *Critical Systems Thinking: A Practitioner's Guide* (2024), he cites the BSc and EFQM as methods for measuring system performance. Whilst the BSC and EFQM are proven methods, there may be an opportunity to focus more on the resources of an entity's capital structure, as possible with Altman's (1968; 1993) Z-score.

The importance of managing capital structure is as important as ever for companies (Attrill & McLaney, 2021). A company's capital structure is more dynamic than we may think, as it strives to finance the entity over the long and short term, as argued by Wild et al. (2007). Financing is used to procure non-current assets and current assets, enabling the company to deliver its products and services to customers. Some assets, such as non-current assets, signify

security to lenders, particularly if the company needs loans to finance its capital structure due to insufficient profits or reserves (Bardia, 2012). If the company needs loans, this introduces risks associated with borrowing to buy assets, as interest charges increase the company's overall cost of capital. It can lead to what Nguyen et al. (2021) refer to as leverage traps: future borrowing is not possible due to the ongoing cost of capital, compounded by business strategy mistakes.

A company's capital structure is crucial to its financial sustainability and long-term market viability (Holmes et al., 2015). According to Szymanski et al. (1993), an optimal borrowing-to-equity capital structure maximises growth and development while minimising the risk of bankruptcy. Capital structure affects the company's ability to win market share: the higher its relative market share, the higher its profitability (Mitani, 2014; Mognetti, 2002). The emphasis on profitability and return aligns with the position of Achim et al. (2010), as the return on a company's investment demonstrates its inherent ability to generate revenue from its operations. Bardia (2012) points to higher returns as indicating the company's ability to generate cash from operations to repay debt and mitigate the risk of insolvency. According to Hussey (2014), high returns, as measured by earnings per share, are also attractive to institutional and private investors.

The imperative appears to be for companies to effectively manage their capital structure and assess their profitability and return on investment (Karadag, 2015). Boigues (2016) calls for profitability and return ratios to measure the efficiency of a company's management team in utilising resources to generate profits, such as return on sales. However, Attrill et al. (2021) highlight the limitations of such ratios, for example, the reliability of financial data and the issue of inflation, which can lead to misleading figures. To address the concerns raised by Attrill et al., there is an opportunity to use more advanced methods to assess company performance, such as Altman's (1968) Z-score.

This paper aims to make the case for using the Z-score to measure system performance by outlining its history, introducing the technique and the data used to compute the Z-score, and discussing its relationship to operational and service delivery systems. Additionally, it discusses the method's utility for measuring system performance.

2. Z-score

This section summarises the history of the Z-score and its independent critique by researchers, such as Bardia (2012).

2.1 The history of the Z-score

The Z-score was empirically developed by Altman in 1968 to predict corporate bankruptcy, thereby better informing institutional and private investors about their potential investments in corporate stock. Altman studied sixty-six manufacturing companies worth over $1 million, of which 50% went bankrupt. Based on his first statistical run of the Z-score, Altman predicted 72% of the bankruptcies before they occurred. Altman believed that predicting the financial success or distress of companies provided a better understanding of company performance and was an improvement on the more traditional methods of investor financial analysis, such as return on shareholder funds. Taffler (1984) confirmed the reliability of the Z-score in forecasting the likelihood of a company failing in the next trading year from its capital structure performance [history], thereby predicting a company's success or distress [future]. He concluded that the Z-score is a predictor that helps companies make informed decisions about their capital structure. Becket (2004) confirmed that the Z-score for failing companies continued to decline as they approached insolvency and eventually bankruptcy.

2.2 Independent critiques of the Z-score

There have been a few interesting critiques of the Z-score, focusing on the data it uses, the accuracy of the method, and its relevance to different industry sectors, such as those by Bardia (2012), Naiping and Li (2011), Hayes et al. (2010), and Gerantonis et al. (2009). Bardia questioned the Z-score because it relies on multiple discriminant analyses, which select specific financial data over other data. Other data may yield a linear function of the multiple explanatory variables, which is equally acceptable. Naiping and Li found that the Z-score for public companies is significantly higher than for private companies. They concluded that the financial risk for private companies is significantly higher than for public companies. In the retail industry, the critique by Hayes et al. concurs with Taffler (1984), as they confirm that the Z-score predicts bankruptcy with 94% accuracy. This finding aligns with Altman (1993), who stated that the Z-score is more reliable in manufacturing and retailing. However, Gerantonis et al.'s cross-sector critique revealed that the Z-score's reliability for predicting failure was 66% in the first year, decreasing to 20% by the fourth year. We can note that the Z-score is likely to

be more reliable in certain industries, such as retailing, than in others when operationalising the Z-score methodology.

2.3 Whose decision is it to use the Z-score in a company

The use of the Z-score and other operational and improvement methods in companies is a decision of their governance and leadership. While leadership provides the general direction of a company (Frawley et al., 2019), governance is responsible for designing, implementing, and monitoring structures, processes, and systems, as outlined in Slack et al.'s (2022) Transformation Process Model. Here, they indicate input from transformed resources, input from transforming resources, and the transformation process for customer service. Although an imperfect model of operations, it illustrates total input costs and revenues. However, Ogland and Evans (2025) cite a lack of governance and leadership as a reason for the high failure rates of TQM projects using models such as the European Foundation for Quality Management (EFQM) Business Excellence Model (Hakes et al., 2007). There seemed to be a disconnect between governance and leadership in the TQM projects they analysed. They concluded that governance is better aligned with organisational commitments and that leadership is distributed and cultivated bottom-up to improve the success rates of TQM projects. A decision to use the Z-score would benefit from aligning governance with the commitment to implement the method and from distributed leadership to ensure the financial management system can track total costs and revenues.

3. Z-score's methodology

Altman (1968; 1993) designed the Z-score to predict bankruptcy and corporate performance using various financial data. It means the Z-score is a composite measure of performance, combining individual measures to provide a comprehensive view of companies' trading and their ability to generate cash flows to cover expenses. Essentially, the Z-score summarises a considerable amount of financial data into a single, easily understandable value. In doing so, the Z-score composite measure reduces the amount of financial data that needs to be processed, providing a clearer picture of a company's overall performance and being useful for benchmarking and monitoring changes over time.

Because of the data it uses, the Z-score is a quantitative methodology for performance analysis (Morris, 2010), albeit discriminatory in the data it uses to compute the final Z-score, as noted by Bardia (2012). The data feeds into the Z-score metric, which utilises five predetermined weights provided by Altman to compute individual classification scores and the final Z-score for a company. Below is the Z-score metric and each weight for the classifications x1 to x5. For example, 0.717 is the weight for x1 and 0.847 for x2, and so on. To emphasise, the weights provided by Altman enable users to multiply the financial data shown in x1 to x5 by the weights to calculate the individual classifications and the final Z. The weights are fixed; thus, users cannot alter them based on their preferences.

$$Z = 0.717 \times [x1] + 0.847 \times [x2] + 3.107 \times [x3] + 0.420 \times [x4] + 0.998 \times [x5]$$

The weights Altman uses do give clues to his thinking on the importance of each classification, x1 to x5. He places the highest weight on x3, 3.107, suggesting he is examining how a company's management team employs its current and non-current assets to generate cash flows, profits, and returns for investors. He probably views this classification as the one more likely to lead to insolvency and bankruptcy if total assets are not utilised effectively to generate sales to cover operating costs. His second priority is x5, 0.998, further highlighting the importance Altman places on generating sales to cover operating costs, thus providing a slightly different measure of a company's asset utilisation rate. x1, 0.717, and x2, 0.847, are of medium priority to him, as they focus on the company's working capital cycle and the earnings generated by the cycle after deducting operating costs. The classification x4 has the lowest weight and appears to reflect the relationship between equity and debt, specifically between short-term and long-term liabilities. Altman likely considers equity, including profit, as a benefit of other classifications, such as x3, and any loans used to procure assets, rather than on how assets are utilised to generate sales.

The final and most important element of the methodology is the Z-score benchmarks to determine whether an entity is experiencing financial success or distress. Indicating improvement, it can also suggest insolvency or an investment opportunity, and we believe the benchmarks reflect system performance. Drawing on the ideas courtesy of Castle (1998; 1996), the extent of system integration and system maturity; thus, an entity scoring ≥2.90 is likely to

have higher system integration and maturity than an entity scoring ≤1.20. Table 1 shows Altman's benchmarks and their interpretation.

Of interest to this research is Altman's focus on a company's total assets to generate sales, which is especially important in the retail industry, such as sports and physical activity. Other sectors have the business decision to outsource manufacturing or production, which is not possible for the delivery of sport and physical activity services. The delivery of sport and physical activity services is a simultaneous process, as argued by Buswell et al. (2022); thus, it is virtually impossible to outsource service delivery. We can now consider the financial data that feeds into the Z-score.

Table 1: Altman's benchmarks and their interpretation (*Adapted from Altman (1968; 1993)*

Benchmark	*What does this mean?*	*System integration & maturity*
≤1.20	A high chance of bankruptcy	Low
≈1.20-2.90	The firm is in a grey area and an ambiguous area	Medium
≥2.90	A low or no chance of bankruptcy	High

4. Financial data used in the Z-score metric

The financial data that feeds into the Z-score metric is deliberately selected by Altman (1968, 1993) and is sourced from companies' accounts, specifically the income statement and the statement of financial position. Other elements in company accounts can help with our financial analysis, though, such as the chairperson and chief executive officer reports and the notes to the accounts that provide detail on how the figures were calculated by the company accountant, including necessary adjustments to comply with the Generally Accepted Accounting Principles

(GAAP) (Hussey, 2014). All accounts are subject to internal and external audits to provide a true and fair view and to confirm that the company is a *going concern*. Compliance with GAAP and audits gives users of such financial information confidence in the data's reliability, despite the concerns raised by Attrill et al. (2021) about the data.

Each classification (x1 to x5) has its own financial data requirements for computing its ratio, which is then used to compute the Z-score metric. Table 2 presents the financial data for each classification, along with our interpretation of the focus of each classification (x1 to x5).

Table 2: Financial data for the classifications

Classification	*Financial data*	*Interpretation*
x1 =	Working capital/total assets	Liquidity
x2 =	Retained earnings/total assets	Age of the firm
x3 =	Earnings before interest and tax/total assets	Profitability
x4 =	Net worth/total liabilities	Financial structure
x5 =	Sales/total assets	Capital turnover

Source: Adapted from Altman (1968; 1993)

Our interpretations of the classifications are based on repeated measures over time (Morris, 2010). x1 appears to concentrate on the company's working capital cycle, given the financial relationship between current assets and liabilities. Additionally, the utilisation of both non-current and current assets is considered within the trading cycle. x2 the level of earnings generated by the company's total assets over the long term, and the condition of the company's non-current and current assets, such as facilities and equipment used to deliver products and services. x3, the level of gross profit generated from sales, less the cost of sales, less business

expenses. Again, the use of non-current and current assets to earn the company's sales for the trading period of interest.

x4, the relationship between the equity invested by the owners and the amount of loan capital, i.e., debt finance, in the company's capital structure. A rule of thumb suggested by Hussey (2014) is 50:50, i.e., equity 50%, debt finance 50%. If debt finance exceeds 50%, it begins to cause problems for a company due to interest payments, thereby squeezing its cash flow. x5, the efficient and effective use of non-current and current assets by the company's management to generate sales. The higher the capital turnover (i.e., utilisation rates), the better. It is fair to say that calculating x1 to x5 is a challenging aspect of using the Z-score for users.

5. Calculating the Z-score for a company

An example of how to compute a company's Z-score is shown here. The Company operates in the sports and physical activity industry. For the sake of fairness, it will be referred to as Sports Co. As an established health and fitness provider, Sports Co. trades across the UK, and its recent accounts report that it is a going concern and optimistic about its future trading activities. Table 3 presents the financial data extracted from the Sports Co.'s Financial Statements.

Table 3: Financial data for the classification ratios

Financial statement	*Nature of the financial data*	*Description*	*£*
Statement of financial position	Working capital	Current assets – current liabilities	298,701
Statement of financial position	Total assets	Non-current + current assets	930,966
Income statement	Retained earnings	Profit saved by the Company	322,024

Income statement	EBIT	Profit from day-to-day operations	-£20,132
Statement of financial position	Net worth	Assets over liabilities	482,423
Statement of financial position	Total liabilities	Current + long-term liabilities	448,543
Income statement	Sales	Income & revenue from trading	224,591

Source: Adapted from Sports Co.

After collecting the financial data from the Statements, we can now calculate the ratio for each classification, x1 to x5. The ratio is what is shown in the brackets of the above Z-score metric, such as [x1], [x2], and so on. Each classification calculation involves a division to compute the ratio, which we then multiply by the weight for that classification, such as x1's 0.717. At no point are the computed ratios converted into percentages, as with other financial ratios, such as profitability and return (Hussey, 2014). Rather, the metric only uses the ratio computed for each classification, x1 to x5. What follows in Table 4 are the workings out for each classification ratio x1 to x5.

Table 4: Calculations for the classification ratios - *Source:* Author

Classification	*Workings out*	*Ratio*
x1 =	£298,701/£930,966	0.320851
x2 =	£322,024/£930,966	0.345903

x3 =	-£20,132/£930,966	-0.02162
x4 =	£482,423/£448,543	1.075533
x5 =	£224,591/£930,966	0.241245

The x1 to x5 ratios can now be multiplied using Altman's predetermined weights. To recap, the user cannot change Altman's weights; they are fixed. The weights are somewhat contentious and attracted criticism from commentators, such as Bhandari (2014). Nonetheless, the Z-score has been shown to be a reliable predictor of financial success or distress across the retail and manufacturing sectors, including sport and physical activity. Further, the repeated-measures (Morris, 2010) underscore the reliability of the Z-score metric and its implications for sports companies, such as insolvency and eventual bankruptcy. Table 5 reports the multiplication of each x1-x5 ratio using Altman's weights.

Table 5: The multiplication of the x1 to x5 ratios using Altman's weights (Source: Author)

Classification	*Workings out*	*Figures for the Z-score metric*
x1 =	0.320851 x 0.717	0.2301
x2 =	0.345903 x 0.847	0.293
x3 =	-0.02162 x 3.107	-0.0672
x4 =	1.075533 x 0.420	0.452

$$x5 = \left| \begin{array}{ll} 0.241245 \text{ x } 0.998 & 0.241 \end{array} \right.$$

We can now input the figures into the metric to compute the Z-score for Sports Co. As you will recall, Sports Co. reported a true and fair view of trading, a going concern and optimistic about its future trading activities. Below is the Z-score for Sports Co. Please note that there are no weights or x1 to x5 ratios in the final model, as we have already accounted for these above.

$$0.2301 + 0.293 + -0.0672 + 0.452 + 0.241 = \mathbf{1.149}$$

The Z-score of 1.149 indicates insolvency and a high likelihood of bankruptcy, which challenges the position of the Sports Co. For us, it is also indicative of poor operations performance.

6. To what extent can the Z-score measure system performance

Here, the system concepts, service system performance, and the Z-score comparison with other operational methods are critiqued to assess the extent to which the Z-score can measure system performance.

6.1 System concepts

For sports and physical activity organisations, such as Sports Co., the relevance of *boundary*, as a system concept (Beer, 1979; Checkland, 1981), is crucial in defining their identity as a trading entity. Many commentators have contested the critical importance of boundary judgements, including Scott et al. (2007), Midgley (2000), and Ulrich (1994). However, the account by Stowell et al. (2012) is the most accessible for making sense of boundary decisions, and Midgley (2000) provides a complementary perspective. Sports Co. is a physical entity that we can recognise through its various elements and its position in the external environment where it delivers products and services. Because the boundary concept is relevant, we can define Sports Co. as,

> A sports and physical activity delivery system for individuals seeking to enhance their health and fitness, support their rehabilitation following an injury or illness, or make lifestyle changes.

We could also illustrate the Sports Co. delivery system using a System Map, as called for by Stowell et al. (2012). A closely related system concept (Checkland, 1981) to boundary is *hierarchy*.

The relationship between hierarchy and boundary is established once the system of interest has been defined. For instance, Sports Co. is a delivery system within the sports and physical activity business environment, operating at the same level as other service providers. At this point, hierarchy becomes more relevant. Beer (1979) views the environment as a system, and systems are nested alongside other systems at the same level of recursion, which are also part of much larger systems. Regardless, the system concepts (Checkland, 1981) apply at all levels of recursion, and Beer's views are applicable to the sports and physical activity sector, as Carter (2005) found from his analysis of national sports resources. Carter concluded that sport is a delivery system, a finding endorsed by Veal (2010), who has long held that leisure, sport, and tourism are interconnected systems connected to other systems, such as public health.

Hierarchy is also relevant internally to organisations through the designed and implemented organisational structures. Sports entities use horizontal and vertical structures to allocate resources and coordinate all work for service delivery. The accounts of Hoye et al. (2022) and Paton et al. (2011) attest to the coordination of efforts across sports entities and service delivery operations, respectively. Hierarchy very much influences the design of entity control systems as well.

Upon further review of the Accounts of Sports Co., it is evident from the Chairman and CEO reports that the entity has control. In their summaries, they indicate performance against the Company Strategy and business objectives. Sports Co., Strategy sets out a clear intent, and the detail in its objectives is wide-ranging. The Board seems alert to trends in their business environment, such as changes in consumer preferences, competitor actions, and consequences of changes to national healthcare policy objectives. How their partnerships and collaborations help achieve their business objectives, too. Their control over the entity is also clear in the Notes to the Accounts, where they provide explanations of the calculations for sales, cost of sales, and business expenses. There is a level of financial transparency to help the reader understand how they arrive at a true and fair view of trading, and why they feel Sports Co. is a

going concern, even though our computed Z-score of 1.149 suggests otherwise. However, based on the threshold for what constitutes financial control as determined by Attrill et al. (2014) and Hussey (2014), Sports Co. appears to meet the control benchmark. Further, the system concept of *control* arises from how it influences purposefulness, as theorised by Checkland (1981).

As much as control is evident in the financial information on Sports Co., so too is *communication*. The operationalisation of its Strategy and business objectives appears well-communicated across Sports Co.'s organisational structures. Checkland (1981) highlights the importance of communication in keeping system actors informed and leveraging their collective experiences to deliver the organisation's products and services effectively. The shared learning among system actors aids the organisation and enhances its knowledge-creation processes. Effective communication engages actors and motivates them to strive further toward achieving business objectives. A different side of organisational communication is its strategy. The strategy communicates intent, assures stakeholders and potential partners, and, to a lesser extent, customers. Thus, Sports Co. mostly satisfies the system concept of communication (Checkland, 1981) in how it reports its business affairs.

It is too difficult to give a view on the system concept of *emergence* (Checkland, 1981). To achieve this, access to Sports Co. is necessary to understand how the entity operates in delivering its products and services. What we can say is that it is responsive to the external environment and is monitoring its performance.

In summary, except for emergence, the system concepts theorised by Checkland (1981), namely boundary, hierarchy, control, and communication, seem to apply to sports entities. Thus, we can argue that sports entities are systems.

6.2 Service system performance

If the case is accepted that Z-score satisfies the system concepts (Checkland, 1981), then to what extent does Z-score measure service system performance, as discussed by Palmer (2018)? There can be little doubt that the Z-score measures the performance of the entire service delivery system, such as Sports Co. The delivery system encompasses not only operations management terms but also service quality terms. Contemporary sport and physical activity venues are designed to maximise the customer experience due to the symbiotic relationship

among the venue's architect, builder, and operator. (Schwartz et al. 2017; 2015). Their triangular relationship is essential to balancing the technical and functional quality requirements (Gronroos, 1984) of design, build, and technical operation.

The delineation of front- and back-office functions, as called for by Shostak (1985) and Eiglier et al. (1987), is crucial for appreciating the interrelationships of space within the sport and physical activity service delivery system. Slack et al. (2022) delineate functions in their operation's Transformation Process Model, arguing that input from transformed resources, input from transforming resources, and the transformation processes for output products and services to customers. They stress this from the customer perspective, i.e., backwards, to maximise customer satisfaction. They also theorise the operation as a macro-operation, i.e., the whole entity, and as a mix of micro-operations, such as reception, food and beverage, health and fitness, rehabilitation, and changing facilities. Slack et al. indicate that each micro is responsible for implementing the agreed-upon operations strategy and is empowered to do so. It suggests a devolved budgeting approach, which is highly motivating for the managers responsible for each micro.

Much of the above would be formalised in an operation's approach to TQM, such as ISO 9000 (Beckford, 2017), to maximise the execution of the service quality imperatives, i.e., intangibility, inseparability, perishability, and ownership (Palmer, 2014). The service quality dimensions are also measured using SERVQUAL (Parasuraman et al., 1988), which assesses tangibles, reliability, responsiveness, assurance, and empathy. We argue that Z-scores' focus on total assets and sales effectively captures service system performance in financial terms, as well as the inter-relationships among the service quality factors.

6.3 Z-score comparison with other operations management methods

If viewing the entity as a Transformation Process Model (Slack et al., 2022) with embedded systems, then there are other methods available to measure system performance, such as Viable System Methodology (VSM) (Beer, 1979), European Foundation for Quality Management (EFQM) Business Excellence Model (Hakes et al., 2007), Balanced Scorecard (BSC) (Kaplan et al., 1996), Integrated Quality System (IQS) (Castle, 1998; 1996), Six Sigma (Clay, 2018), and the Value Chain (Porter, 1985). The popularity of these methods is evident in Slack et al.

(2022), particularly those aligned with TQM, such as EFQM. Ogland and Evans (2025) empirically demonstrated that TQM is more alive than dead, albeit requiring a critical version for contemporary organisations to cope with their environmental complexities and called for a Critical Total Quality Management (CTQM) approach.

Beer's (1979) VSM measures the productivity and latency of a system using indices to improve the efficiency and effectiveness of organisational systems and processes. The improvement to systems and processes is then accomplished using the VSM five sub-systems: 1. Operations, 2. Coordination, 3. Delivery Management, 4. Strategy, and 5. Governance. By applying sub-systems to redesign systems and processes, organisations can significantly enhance their performance, as demonstrated by Sadd et al. (2022) in their application of VSM to create FAME for event planning and management.

EFQM (Hakes et al., 2007) measures business excellence by focusing on enabling and results, including customer results. A high-performing business excellence organisation would score 500+ points out of 1,000, and the difference between the two scores would be an area for leaders to focus on, resources permitting, of course. An appeal of the EFQM is its self-assessment and external validation, and the use of the EFQM Framework can lead to the design and redesign of organisational systems. The EFQM is relevant to private and public entities.

Kaplan et al. (1996) developed the BSC to shift organisations away from just financial measures of performance to a more balanced set of twenty-six indicators focused on learning and growth, customers, internal processes, and financials. Kaplan et al. believed these are critical measures of organisational performance and stimulate improvement when the twenty-six indicators are below the pre-set target. The BSC remains popular and can be used to operationalise strategic objectives, alongside performance measures. A scorecard is unique to each entity and compares its performance across trading periods. It is a self-assessment, but no external validation is provided.

IQS, pioneered by Castle (1998; 1996), measures systems integration and maturity. Although IQS can measure service integration and maturity, its design is inspired by operations management. IQS measures integration and maturity across eight systems: environment, control, strategy and policymaking, focus, production improvement, service, and competitors. IQS uses predetermined statements to compute the overall percentages. Like the EFQM, an

integrated and mature organisation system needs to score ≥50%. However, from Castle's empirical work with IQS, few organisations score ≥50%, even if scoring 500+ using the EFQM metric. Castle believes an integrated, mature system is close to excellent and unlikely to cause customer dissatisfaction. Evans et al. are developing an IQS version to measure organisational governance and leadership.

Six Sigma (Clay, 2018) stimulates improvement across all operations management functions by prioritising defect reduction, minimising variability, and enhancing overall quality and efficiency. All this is designed to reduce costs, increase customer satisfaction, and achieve this through greater employee engagement. Brook (2024) also argues that Six Sigma can sustain competitive advantage and overall profitability in the long run.

Porter's (1985) Value Chain also measures profit through primary and support activities. His Value Chain prompts organisations to seek new synergies and configurations of primary and support activities to generate higher profit margins. The margins materialise through higher sales because of changes to the organisation's Value Chain. Value Chain analysis is a self-assessment exercise with no external validation. For an organisation to realise the benefits of Value Chain analysis, its cost and management accounting processes must account for each primary and support element, such as purchasing, IT, and logistics, as well as the BCG, DPM, and product life cycle (Koch, 1995).

In short, VSM (Beer, 1979) focuses on improving organisational systems and processes, EFQM (Hakes et al., 2007) business processes excellence, the BSC (Kaplan et al., 1996) on balanced indicators for critical systems, IQS (Castle, 1998; 1996) system integration and maturity, Six Sigma (Clay, 2018) on efficiencies of the operations function, and the Value Chain (Porter, 1998) net profit margins via new synergies and configurations of the Value Chain. Each method measures a different thing, so the Z-score complements these methods.

7. Discussion

The z-score (Altman, 1968) is proposed as a statistical technique for measuring system performance. It differs from other methods in that it is a composite measure of system performance, serving as an economic framework for performance measurement. Because of

this, when we use a Z-score, we perceive its purpose as producing a *systemic coefficiency of performance* for the system of interest, such as Sports Co.

Z-scores measure something different from other methods; thus, they complement them. We perceive its main strengths as a holistic measure of performance. It does not use averages, which was a criticism of SERVQUAL (Parasuraman et al., 1988), and its averaging of averages, which hides a multitude of sins until paired testing was introduced. All the Z-score calculations are based on audited financial data, and for us, the Z-score measures much more than either financial distress or success. For instance, x5 focuses on sales systems and processes, including customer satisfaction, service staff productivity, booking systems, programming, and sales and marketing systems, as called for by McDonald et al. (2016). x3, total assets, i.e., non-current and current assets necessary to deliver products and services to customers, including all asset management systems. Thus, the Z-score will produce an economic measure for each system Transformation Process Model (Slack et al., 2022).

Of course, Z-scores have weaknesses, such as reliance on historical financial data, the language of financial management, which can be daunting to some, and the perceived wizardry of the technique. Some might find interpreting the x1 to x5 ratios difficult, particularly when determining the final Z-score for a system. The fact that no qualitative data is used, some would argue, potentially limits the analysis of a system's performance, as highlighted by Attrill et al. (2022).

The decision to use Z-scores is ultimately one of governance and leadership, regardless of whether it is corporate or nonprofit governance. It is true for the theory of governance we may use to describe governance within entities, such as agency, institutional, or resource dependency, as suggested by Clark (2004). We see the purpose of governance and leadership is to implement the structures and processes necessary to achieve strategic goals, objectives, and direction, and to monitor performance against these imperatives, as endorsed by Hoye et al. (2022). Ogland et al. (2025) also called for governance and leadership to effectively implement TQM initiatives, such as ISO 9000 and Six Sigma, as often the missing activity that leads to TQM projects failing or, at the very least, delivering modest operational efficiencies or customer satisfaction indices. These observations undoubtedly point to an opportunity to apply the Z-score to TQM and project management, as these will present very different challenges for the model's utility.

Firkins et al. (2012) stress four strategic roles for entities and their second: to set a very clear vision and mission for the organisation, and to develop the skills to monitor progress towards the strategic goals. They view this as a critical capability of governance and leadership. Likewise, Henry et al. (2004) highlight efficiency and effectiveness as two of their eight good principles of organisational governance. However, Geeraert et al. (2022) remain highly sceptical of organisations and their monitoring and control processes. The Z-score would help address this as a whole-system measure, and one focused on the utilisation of resources by managers, even though work would be required to establish the x1 to x5 baseline measures using an organisation's historical financial data.

Nonetheless, having used Z-score on multiple occasions, the user can supplement its analysis with alternative ratios, such as long-term stability and solvency (Hussey, 2014). Many BSc and MSc students have done this, leading to more probing analyses, such as Ballam (2022). Z-score complements well the System Dynamics (Forrester, 1961), type methods, such as Warren's (2008) strategic management dynamics and its focus on future performances through time, Morecroft (2007) strategic modelling and business dynamics to improve feedback systems, and Sterman (2000) and his systems thinking and modelling for a complex world through the use of causal diagrams. Because of these benefits, we feel the Z-score is a valuable inclusion in the methods for system analysis; however, as a *systemic coefficency of performance*.

8. Conclusion

This paper presents a case for the inclusion of the Z-score (Altman, 1968; 1993) in system performance analysis. We believe the Z-score is a useful measure, and we will continue to use the technique for the *systemic coefficiency of performance* measure of a system of interest.

As we move forward, we will continue to apply the Z-score in the sport and physical activity sector and further investigate the x1-x5 weights. We intend to create baseline ratio measures for the different types of sport and physical activity organisations and develop other measures to supplement the x1 to x5 ratios and the final Z-score for the system of interest. Lastly, to introduce systems thinking, systems practice (Checkland, 1983) to BSc and MSc students.

References

Achim, M. V. & Borlea, S. N. (2010). Business Performances: Between profitability, return and growth. Annals of the University of Craiova Economic Series, 2 (38), 1–12.

Altman, E. I. (2013). Predicting financial distress of companies: Revisiting the Z-score and ZETA models. In Bell, A. R., Brooks, C. & Prokopczuk, M. 2013. *Handbook of research methods and applications in empirical finance*, Cheltenham: Edward Elgar Publishing.

Altman, E. I. (1968). Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy. *Journal of Finance*, 23 (4), 589-609.

Attrill, P. & McLaney, E. (2021). *Accounting and Finance for Non-Specialists*, 12th Edn. Harlow: Pearson.

Ballam, L. (2022). An investigation into capital structure in the UK health and fitness industry using the Z-score method, *Bournemouth University Business School*, June 2022.

Bardia, S. C. (2012). Predicting Financial Distress and Evaluating Long-term Solvency: An Empirical Study, *IUP Journal of Accounting Research & Audit Practices*, 11 (1),47–61.

Beckford, J. (2017). *Quality: A Critical Introduction*, 4th Edn. London: Routledge.

Becket, M. (2004). *How the Stock Market Works: A Beginner's Guide to Investment*, 4th Edn. London: Kogan Page Publishers.

Beer, A. S. (1979). *The Heart of Enterprise*, London and New York: John Wiley & Sons.

Bhandari, S. B. (2014). Two Discriminant Analysis Models of Predicting Business Failure: A Contrast with the First Model, *American Journal of Management*, 14 (3), 11–19.

Boigues, S. R. (2016). *An empirical factor analysis of efficiency and profitability ratios in the US retail industry*, Michigan: ProQuest.

Buswell, J., Williams, C., & Sutton, C. (2022). *Service quality in leisure, events, tourism and sport*, 2nd Edn. Wallingford: CABI Publishing.

Carter, P. (2005). *Review of National Sport Effort and Resources*, London: Sport England.

Castle, J. A. (1998). New methodologies for integrating quality management, *The TQM Magazine*, 10 (2), 83–88.

Castle, J. A. (1996). An integrated model in quality management, TQM, BPR and ISO 900, *The TQM Magazine*, 8 (5), 7–13.

Checkland, P. B. (1981). *Systems Thinking, Systems Practice*, Chichester: John Wiley & Sons.

Clarke, T. (2004). *Theories of Corporate Governance*, Oxon, UK: Routledge.

Clay, K. (2018). *Why They Fail… and the Simple Keys to Success*, Dallas: Six Sigma Development Solutions, Inc.

Eiglier, P. & Langeard, P. (1987). *Servuction*, New York: McGraw-Hill.

Ferkins, L. & Shilbury, D. (2012). Good boards are strategic: What does that mean for sport governance of sport organisations, *Journal of Sport Management*, 26, 67–80.

Forrester, J. W. (1961). *Industrial Dynamics*, Cambridge, Mass: MIT Press.

Gerantonis, N., Vergos, K. & Christopoulos, A. G. (2009). Can Altman Z-score Models Predict Business Failures in Greece? *Research Journal of International Studies*, 12 (10), 21–28.

Geeraert, A. & van EeKeren, F. (2022). *Good Governance in Sport: Critical Reflections*, London: Routledge.

Gronroos, C. (1984). A service quality model and its marketing implications, *European Journal of Marketing*, 18 (4), 36-43.

Hakes, C. & Wilkinson, J. (2007). *The EFQM Excellence model for Assessing Organisational Performance: A Management Guide*, Van Haren Publishing, Zaltbommel, www.vanharen.net

Hayes, S. K., Hodge, K. A., & Hughes, L. W. (2010). A study of the efficacy of Altman's Z to predict bankruptcy of speciality retail firms doing business in contemporary times. *Economics and Business Journal: Inquiries and perspectives*, 3 (1), 122–134.

Henry, I. & Lee, P. C. (2004). Governance and ethics in sport, in J. Beech and S. Chadwick (eds). *The Business of Sport Management*, London: Prentice Hall.

Hussey, R. (2014). *MBA Accounting*, Basingstoke: Palgrave Macmillan.

Holmes, K., Hughes, M., Mair, J. & Carlson, J. (2015). Events and Sustainability, Abingdon: Routledge.

Hoye, R., Smith, H. C. T., Nicholson, M. & Stewart, B. (2022). *Sport Management: Principles and Applications*, 6th Edn. London: Routledge.
Kaplan, R. S. & Norton, D. P. (1996). *The Balanced Scorecard: Translating Strategy into Action*, Boston, Massachusetts: Harvard Business School Press.
Karadag, H. (2015). Financial Management Challenges in Small and Medium-sized Enterprises: A Strategic Management Approach. *Emerging Markets Journal*, 5 (1), 26-40.
Koch, R. (1995). *Strategy: How to Create and Deliver a Useful Strategy*, London: FT & Pitman Publishing.
McDonald, M. (2016). *Marketing Planning: Understanding Marketing Plans and Strategy*, 2 Edn. London: Kogan Page.
Midgley, G. (2000). *Systemic Intervention: Philosophy, Methodology and Practice*. New York: Kluwer Academic & Plenum Publishers.
Mitani, H. (2014). Capital structure and competitive position in the product market. *International Review of Economics & Finance*, 29, 358–371.
Morecroft, J. (2007). *Strategic Modelling and Business Dynamics: A feedback systems approach*, Chichester: John Wiley & Sons, Ltd.
Morris, C. (2010). *Quantitative Approaches in Business Studies*, 7th Edn. Harlow: Pearson's Education Limited.
Mognetti, J. F. (2002). Organic Growth: *Cost-effective Expansion from Within*, Chichester: Wiley & Sons.
Nguyen, N. T. V., Nguyen, C. T. K., Ho, P. T. M., Nguyen, H. T., & Nguyen, D. V. (2021). How does capital structure affect a firm's market competitiveness? *Cogent Economics & Finance*, 9 (1), 2002501.
Naiping, Z. & Li, Z. (2011). The evaluation of financial risks of listed companies based on the empirical evidence from the Chinese Stock Market, *Tiangsu University*, China: Zhenjiang.
Ogland, P. & Evans, G. (2025). Total Quality Management: Dead or Alive? *Systemist,* Vol. 26, (1), pp.2-27
Ogland, P. & Evans, G. (2025). Fact of Fiction: TQM's Need for Governance and Leadership, *Systemist,* Vol. 46, (1), pp.1-14
Palmer, A. (2014). *Principles of Services Marketing*, 7th Edn. Maidenhead: McGraw-Hill.
Parasuraman, A., Zeithaml, V. A. & Berry, L. L. (1988). SERVQUAL: A multiple scale for measuring consumer perceptions of service quality, *Journal of Retailing*, 62 (Spring), 12–40.
Paton, S., Clegg, B., Hsuan, J. & Pilkington, A. (2011). *Operations Management*, London: McGraw-Hill.
Porter, M. E. (1985). *Competitive Advantage: Creating and Sustaining Superior Performance*, New York: Free Press.
Sadd, D., & Evans, G. (2022). The development of a new framework for assessing major events informed by systems thinking. *Systemist*, *43*(1), 25–48.
Schwarz, E. C., Westerbeek, H., Liu, D., Emery, P. & Turner, P. (2017). *Managing Sport Facilities and Major Events*, 2nd Edn. London: Routledge.
Schwarz, E. C., Hall, S. A. & Shibli, S. (2015). *Sports Facility Operations Management: A Global Perspective*, 2nd Edn. London: Routledge.
Scott, W. R. & Davis, G. F. (2007). *Organizations and Organizing: Rational, Natural, and Open System Perspectives*, New Jersey: Pearson International Edition.
Shostack, G. L. (1985). Planning the service encounter, in J. A. Czepiel, M. R. Solomon & C. F. Suprenant (eds), *The Service Encounter*, Lexington, MA: Lexington Books, 243–54.
Slack, N., Brandon-Jones, A. & Burgess, N. (2022). *Operations Management*, 10th Edn. Harlow: Pearson.
Sterman, J. D. (2000). *Business Dynamics: Systems Thinking and Modelling for a Complex World*, New York: Irwin McGraw-Hill.

Szymanski, D. M., Bharadwaj, S. G. & Varadarajan, P. R. (1993). An analysis of the market share and profitability relationship. *Journal of Marketing*, 57(3), 1-18.

Stowell, F. & Welch, C. (2012). *The Manager's Guide to Systems Practice: Making Sense of Complex Problems*. Wiley.

Taffler, R. J. (1984). Empirical models for the monitoring of UK corporations. *Journal of Banking and Finance*, 8 (2), 199–227.

Ulrich, W. (1994). *Critical Heuristics of Social Planning: A new approach to practical philosophy*, 2nd Edn. New York and London: John Wiley & Sons.

Veal, A. J. (2010). *Leisure, Sports and Tourism: Politics, Policy and Planning*, Wallingford: CABI Publishing.

Warren, K. (2008). *Strategic Management Dynamics*, Chichester: John Wiley & Sons, Ltd.

Wild, J. J., Subramanyam, K. R., & Halsey, R. F. (2007). *Financial Statement Analysis* [online], New Delhi: Tata and McGraw-Hill Publishing Company Ltd.