DATA DRIVEN STRATEGIC AND FINANCIAL MANAGEMENT FOR ENHANCING COMPETITIVE ADVANTAGE IN SCIENCE AND TECHNOLOGY-BASED SMES

Dr. Ravinder Sharma[1*], Dr. Shyam Maurya[2]

[1*]*Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.*
e-mail: ku.ravindersharma@kalingauniversity.ac.in,
orcid: https://orcid.org/0009-0000-9569-6351
[2]*Assistant Professor, Kalinga University, Naya Raipur, Chhattisgarh, India.*
e-mail: ku.shyammaurya@kalingauniversity.ac.in,
orcid: https://orcid.org/0009-0006-3442-8621

SUMMARY

This paper discusses how data-based strategic and financial management can contribute to the competitive advantage of science and technology-based Small and Medium-sized Enterprises (SMEs). SMEs are challenged to use data to make better business decisions in an ever-dynamic and technology-driven market. This research combines data analytics into a strategic and financial management system, and it reveals how real data insights could simplify operations, project trends, cost less, and increase profits. The paper measures the effectiveness of the data-driven strategies in influencing the major financial outcomes, such as ROI, profit margins, and return on assets (ROA), through statistical analysis, regression models, and performance metrics. The study design integrates surveys, interviews, and financial performance data of SMEs to evaluate the success of such strategies in developing long-term growth and innovation. According to key findings, SMEs that use data analytics are better placed in terms of financial stability, resource allocation, and market share. The paper concludes with discussions on the need to constantly integrate data into business operations and recommends that machine learning, AI, and big data analytics have a colossal potential to enhance the accuracy of forecasts, financial planning, and customer interactions. The next research ought to be directed towards the incorporation of new technology to enhance data analytics procedures and give SMEs a sustainable competitive advantage in a dynamic global market.

Key words: *data-driven strategies, financial management, competitive advantage, SMEs, machine learning, AI, financial forecasting.*

INTRODUCTION

The current business landscape, which is fast and dynamic, places an enormous pressure on science and technology-based Small and Medium-sized Enterprises (SMEs) to be innovative and adaptable in order to remain competitive [2]. With the rise of more technology-driven markets, the capacity to use data to make strategic and financial decisions has become a defining trait of long-term success [17]. Nevertheless, most SMEs in the science and technology sectors are struggling to adopt data in their

management systems [1]. This disconnect makes them unable to maximize the potential of data analytics, which can make operations smoother, foresee trends, save on costs, and maximize profitability. These companies are therefore unable to streamline their operations and outcompete others in a more data-driven world [16].

The introduction of data analytics to the strategic and financial management processes allows SMEs to become more efficient in their operations, predict changes in the market, and make suitable decisions due to real-time data [9] [6]. Through information-driven business, SMEs have a chance to manage risks well, enhance innovation, and make sound financial decisions that have long-term growth potential [5]. Nevertheless, not all SMEs create and act on these data-driven strategies, which prevents them from quickly responding to changes in the market [20]. The importance of this study is that it aims to offer practical information on how SMEs in the science and technology sector can embrace the power of data to enhance their competitive stance [8]. These companies may predict customer needs more effectively, align business strategies with new trends, and guarantee a long-lasting success using data as the basis of their decision-making [18]. In the modern era of technology and innovation as the distinguishing factors, the use of data-driven strategies is central to keeping up with the competitive edge in the market.

Key Contribution

1. The article indicates that data-driven strategies are important in improving the strategic and financial management of science and technology SMEs.
2. It offers a context for incorporating data analytics in business decision-making to enhance the efficiency and profitability of operations.
3. The study examines the potential opportunities of using the current developments in machine learning, artificial intelligence, and big data to streamline forecasting and financial planning in SMEs.

Section I provides the background of the SMEs' issues with the integration of data analytics in strategic and financial management. Section II discusses the literature on data-driven decision-making and its role in sustaining a competitive advantage. Section III provides the methodology with data collection and analysis methods. Section IV brings out the significance of data analytics in strategic management. In section V, there is a discussion about financial management strategies. Section VI discusses the merging of data and financial strategies. Section VII ends with critical findings and research directions for the future.

LITERATURE REVIEW

The practice of data-driven decision-making (DDDM) is more recent, in which business decisions are informed by data and not just by intuition or experience [3]. It is the process of gathering, evaluating, and processing large amounts of data in order to identify patterns, trends, and actionable information. DDDM can empower managers and leaders in SMEs to make sound and objective decisions that can facilitate both long and short-term strategies [19] [10]. Through data analytics, companies will have a better insight into the behavior of customers, market trends, and operational efficiencies, which is essential to remain competitive in a fast-evolving industry.

Strategic management is critical in increasing the competitive advantage, especially in science and technology sectors [4]. It entails making long-term goals clear, identifying growth prospects, and aligning company resources to exploit such prospects [15]. Strategic management, when combined with data analytics, is more agile and responsive to market changes and more enabled to capitalize on technological progress [13]. Through real-time data, businesses are able to make better decisions that keep them ahead of the market, with a sustainable advantage. Such evidence-based decisions in strategies improve the allocation of resources, faster reaction to changes in the market, and adaptation to new technologies [7].

The management of finances in science and technology firms involves financial stability and innovation [14]. It is geared towards developing strong financial strategies, effective cash management, and funding

research and development (R&D). Financial strategies based on data will aid the company in making predictions, planning contingencies, and risk management [11]. Companies will be in a better position to invest capital in innovation, utilize their resources efficiently, and determine the financial feasibility of new technologies with data [12]. Effective financial forecasting also helps firms to maximize their budget and invest in maximizing the growth and profit potential of their areas.

Embarking on data-based decision-making in strategic and financial management boosts the capacity of science and technology firms to stay competitive. Through the use of real-time data, businesses can make more informed decisions in order to maximize resources, enhance financial stability, and contribute to long-term growth. The strategy helps SMEs to overcome the challenges of innovation and market volatility, optimize profitability, and maintain a competitive edge in a volatile market.

METHODOLOGY

Figure 1 shows the study design to measure the efficacy of information-based solutions in science and technology-based businesses. It has four important sections as Data Collection that entails surveys and financial performance data; Analysis Techniques that entail Descriptive statistics, Regression Analysis, Benchmarking and Performance Metrics Evaluation; Performance Evaluation that involves Strategic Performance, Financial Performance and Operational Efficiency and finally Findings and Insights that provide actionable insights such as Informed Decisions, Competitive Advantage, Financial Stability and Growth Opportunities that lead to recommendations on improvement of SME performance.
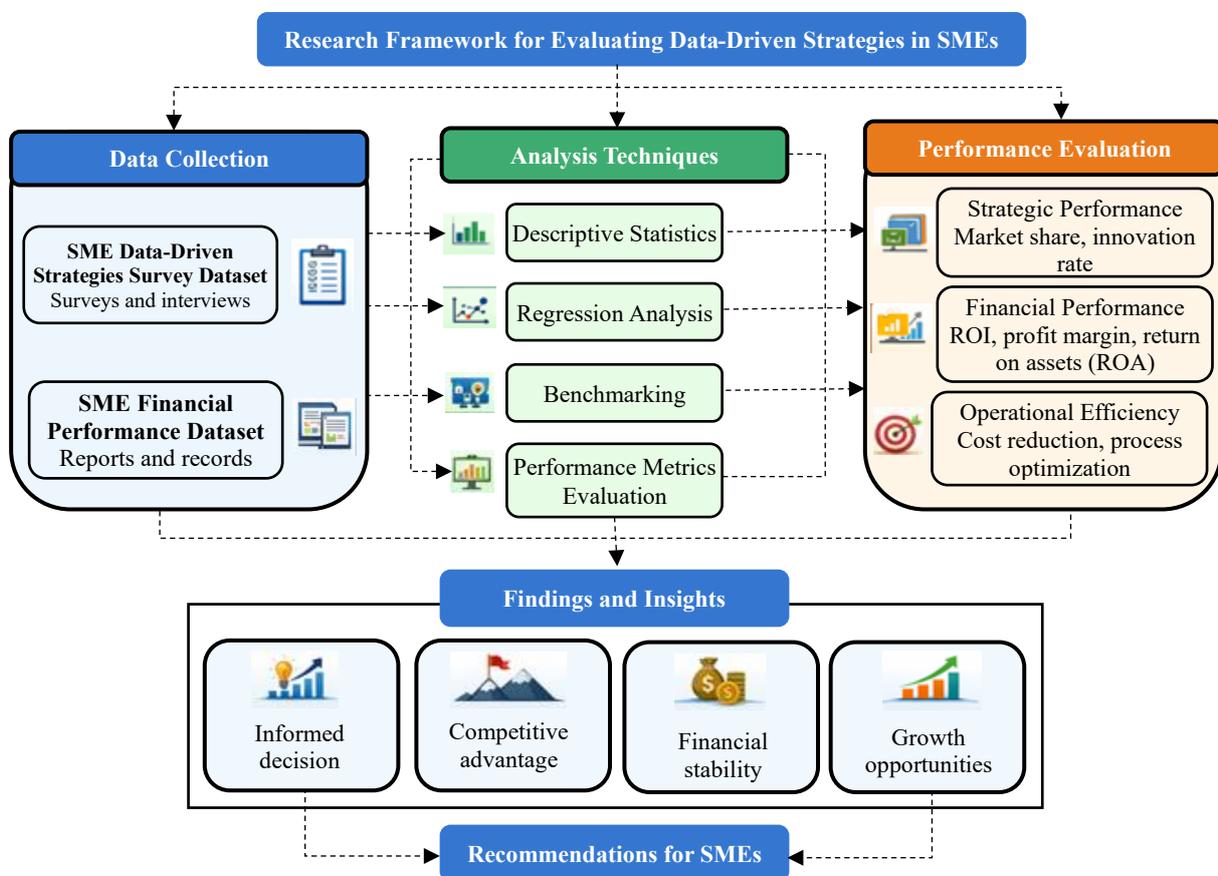

Figure 1. Research framework for evaluating data-driven strategies in SMEs

Research Design and Data Collection Methods

The study is quantitative in nature, as it involves gathering and examining data of science and technology-based SMEs deploying data-driven approaches to strategic and financial management. The research will test how well these strategies improve competitive advantage. The process of data collection consists of two parts:

Primary Data: Survey and structured interviews with business leaders, financial managers, and decision-makers of a sample of SMEs in the science and technology industry. The interviews will be concerned with acquiring data regarding their use of data analytics to make decisions, financial plans, and strategies. The information on this aspect is referred to as the SME Data-Driven Strategies Survey Dataset.

Secondary Data: Industry reports, financial statements, and records of the companies that provide quantitative data regarding the performance of the SMEs. The secondary data would help in tracking the financial performance, major financial indicators, and strategic outcomes related to data-driven strategies. This element is referred to as the SME Financial Performance Dataset.

Analysis Techniques for Evaluating Strategic and Financial Performance:

The data obtained will be processed statistically and with data analytics. The discussion will aim at assessing the effects of data-driven strategies on the strategic and financial performance of SMEs. The major methods employed in the analysis are:

Descriptive Statistics

Mean (Average): The mean represents an average of a data set (i.e., average ROI or profit margin) that adds up central tendency in the data (Equation 1).

$$\mu = \frac{1}{N}\sum_{i=1}^{N} x_i \tag{1}$$

Standard Deviation: Standard deviation shows to what extent the values are distributed around the mean, which gives an idea of the variability of financial performance (e.g., fluctuations in ROI) (Equation 2)

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \mu)^2} \tag{2}$$

Regression Analysis

Simple Linear Regression: his formula is applied to predict the correlation between one independent variable (e.g., data-driven strategies) and another (e.g., financial success such as ROI). It assists in the quantification of the effect changes in X have on Y (Equation 3).

$$Y = \beta_0 + \beta_1 X + \epsilon \tag{3}$$

Multiple Linear Regression: This is a more complicated form of linear regression, which considers the effect of more than one independent variable (e.g., marketing spends, R&D investment) on Y (e.g., market share or financial performance) (Equation 4).

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \epsilon \tag{4}$$

R-Squared: The R-squared value measures the level of goodness of fit of the regression model. It is a measure of how much the independent variables (e.g., data-driven strategies) explain the variance in the dependent variable (e.g., market share). The greater the R 2, the better (Equation 5).

$$R^2 = 1 - \frac{\sum_{i=1}^{N}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{N}(y_i - \bar{y})^2} \tag{5}$$

Benchmarking

Return on Investment (ROI): ROI is a measure of investment profitability, which is used to compute the profit that is made as a proportion of investment expended. It helps to determine the success of financial returns in data-based strategies (Equation 6)

$$ROI = \frac{\text{Net Profit}}{\text{Investment Cost}} \times 100 \qquad (6)$$

Market Share: This equation identifies the percentage of the industry sales made by a company and represents what percentage of the market is captured by the application of data-driven strategies by the SMEs compared to their competitors (Equation 7).

$$\text{Market Share} = \frac{\text{Company's Sales}}{\text{Total Industry Sales}} \times 100 \qquad (7)$$

Performance Metrics Evaluation

Net Profit Margin: ROA indicates how a business can make a profit with its assets. The formula is used to determine the usefulness of using assets to produce returns, a key financial performance metric of data-driven companies (Equation 9).

$$\text{Net Profit Margin} = \frac{\text{Net Profit}}{\text{Revenue}} \times 100 \qquad (8)$$

Return on Assets (ROA): ROA indicates how a business can make a profit with its assets. The formula is used to determine the usefulness of using assets to produce returns, a key financial performance metric of data-driven companies (Equation 9).

$$\text{ROA} = \frac{\text{Net Income}}{\text{Total Assets}} \times 100 \qquad (9)$$

Cost-to-Revenue Ratio: This ratio indicates the ratio of the revenue the company has used to operate. The lower the ratio, the more effectively the company manages costs and operates, which is significant in evaluating the effectiveness of cost control measures in SMEs (Equation 10).

$$\text{Cost-to-Revenue Ratio} = \frac{\text{Total Costs}}{\text{Total Revenue}} \times 100 \qquad (10)$$

DATA-DRIVEN STRATEGIC MANAGEMENT

Importance of Data Analytics in Decision Making

Data analytics have become a part of contemporary decision-making, particularly strategic management. Analyzing big data can help companies make discoveries that are not recognizable by humans. Data analytics is applied in science and technology to detect market trends, evaluate consumer behavior, and streamline operations. The knowledge acquired enables firms to formulate accurate strategies to tackle certain market demands and technology issues.

Figure 2 shows how data analytics has been integrated into key management functions, strategic management, operational management, financial management, and performance measurement to facilitate informed, data-driven decisions in SMEs. At its core, data analytics can assist businesses in setting goals, recognizing market prospects, and creating accurate strategies, which are compatible with real-time information. It also pushes the operational management to streamline processes, assign resources, and constantly monitor performance, which ensures that it is aligned with the organizational objectives and promotes operational efficiency.

The model also enables financial management by data-driven financial planning, forecasting, and risk management, which sustains financial stability. It is used in the performance measurement to efficiently

track KPIs and financial measures, to assess business results, and to create insights to improve further. With these elements combined, the framework makes sure that decision-making is responsive, agile, and aligned with strategic goals and real-time data, which forces the growth, profitability, and sustainable competitive edge of SMEs in the dynamic markets.
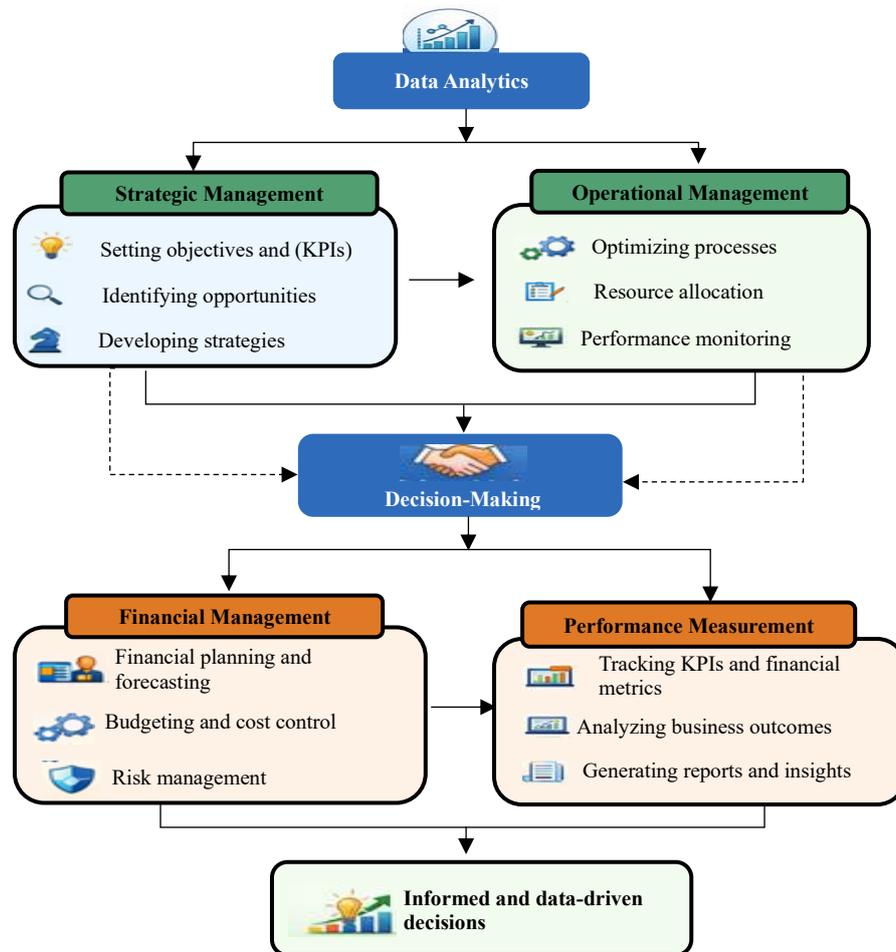

Figure 2. Data and financial management integration

Implementation of Data-Driven Strategies

Application of analytics tools in data-driven strategies entails the incorporation of analytics tools in every business process, including product development, marketing, and customer service. This starts with the gathering of the relevant data related to a variety of sources, including customer interaction, sales, and market trends. After cleaning and processing the data, it will be analyzed using software that can use statistical models and machine learning algorithms on the data to identify the patterns and trends to ensure that a business makes informed decisions in real time. Such a plan enhances the effectiveness of the work, creates a constant increase, and allows companies to adjust to the market changes rather rapidly. Data assists businesses in becoming competitive through optimization of resources, innovation, and performance monitoring, and hence long-term sustainability.

FINANCIAL MANAGEMENT FOR COMPETITIVE ADVANTAGE

This segment discusses the way financial management strategies can help SMEs (especially in science and technology) gain a competitive edge. It emphasizes the role of financial planning, cost management, and performance monitoring and provides SMEs with the means to streamline resource distribution, enhance profitability, and long-term development. The methods and techniques to be employed to attain these objectives are as follows:
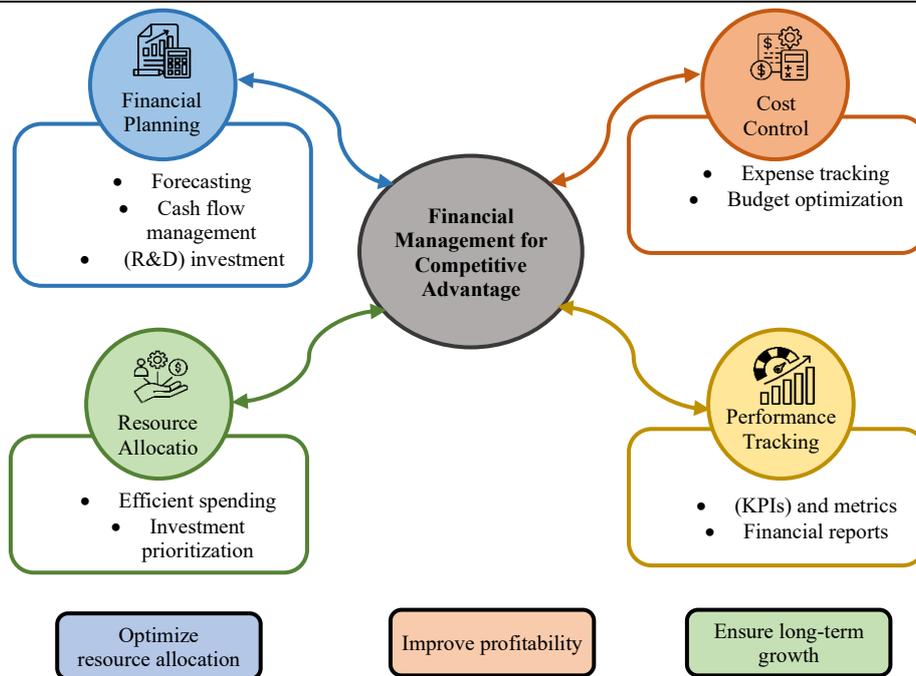
Figure 3. Financial management for competitive advantage

Figure 3 shows the main elements of financial management that allow SMEs to become competitive, especially in the science and technology sectors. It brings to the focus key domains like financial planning, cost control, resource allocation, and performance tracking. These factors interact to maximize decisions, enhance profitability, and guarantee long-term growth. The diagram graphically illustrates the strategic interrelationship of these spheres in that they all combine to help a company thrive in dynamic, competitive markets.

Science and Technology Financial Planning and Forecasting

Financial planning and forecasting in the fast-changing science and technology industry are crucial for SMEs to keep up with the competition and advance innovation. These firms tend to incur high initial research and development (R&D) costs and have to expect market shifts and new opportunities. Through data analytics, SME can predict market conditions in the future, forecast cash flows, and anticipate resources. Such insights help businesses to make sound financial choices and strategize for growth. As an example, predictive analytics can be utilized to simulate different financial scenarios using past data to assist the SMEs in the efficient allocation of funds and future investments in innovation planning. Through proper financial forecasting, firms are able to attract the required funding, be it investors, loans, or grants, and invest intelligently in the potential projects. This helps the SMEs have better control over their resources, eliminate financial risks, and have the financial flexibility to pursue new opportunities in the competitive and dynamic technology environment.

Cost Management and Budgeting Strategies

One of the most important areas of financial management of SMEs, especially in the science and technology industries, is cost control, because the costs of innovation, R&D, and specialized labor may be high. Cost management will keep the company profitable and stable enough to pursue innovation. The two most common approaches to budgeting, such as zero-based budgeting (ZBB) and activity-based costing (ABC), provide an analytical approach to the allocation of resources and monitoring costs.

- Zero-based budgeting starts with a clean sheet annually and requires that every department justify its budget, unlike adopting the one from the previous year. This will lead to greater resource allocation since all the expenditures will be necessary and in accordance with the strategic interests of the company.

- Activity-based costing helps the company establish the true costs of each activity or project so that the company can identify the areas of inefficiency or excessive spending. It is particularly applicable in the field of R&D when there is a need to keep the costs properly monitored and invested in compliance with the long-term goals of the company.

By using data analytics, which constantly monitors the expenses, SMEs have a chance to avoid unnecessary spending and distribute resources to activities that produce the most significant returns and ensure that all the money is put to profitable use. Through proactive implementation, they would be able to focus on the projects that have the largest potential and get the maximum returns on their investments in research and development.

Financial Metrics as a Performance Tracking

Financial metrics are useful instruments in monitoring the effectiveness of a firm's financial strategies and in keeping it on course to long-term expansion. Ratios (including Return on Investment (ROI), Gross Profit Margin, and Net Present Value (NPV)) are commonly used to evaluate the financial performance of an SME and make decisions:

- Return on Investment (ROI) is a measure of the profitability of investments, which illustrates the level of profit relative to the expenditure. High ROI implies that the company is efficiently investing, whereas low ROI might suggest the need to utilize the resources differently.
- Gross Profit Margin is a percentage showing the amount of revenue from which the cost of goods sold (COGS) is less than. It assists in evaluating production and pricing policies. An increase in the margin means that the cost of production is controlled better or the price is successful, whereas a decrease in the margin may necessitate cost control adjustments in cost models or price models.
- NPV measures the profitability of an investment by determining the present value of the future cash flows expected, less the initial investment. Positive NPV implies the creation of value in the investment, and negative NPV implies that the project might not be viable.

Table 1. Sample financial metrics and their strategic implications

Financial Metric	Value
Return on Investment (ROI)	15%
Profit Margin	20%
Net Present Value (NPV)	$500,000
Gross Profit Margin	30%
Return on Assets (ROA)	8%
Cash Flow	$1,200,000

Table 1 shows sample financial measures that are usually used to evaluate the financial performance of science and technology-based SMEs. The figures given serve as representative examples of how the metrics are used to make strategic decisions. Such measures emphasize the role of evidence-based approaches in shaping critical business functions like investment decisions, cost control, and efficiency in operations in competitive markets.

DATA AND FINANCIAL MANAGEMENT INTEGRATION

Significance of Data-Financial Strategy Congruency

To become profitable both in the short and long term, it is crucial that data-driven strategies be aligned with the financial management of SMEs. Companies can make sound decisions by combining data analytics-based insights and financial planning to enhance strategic performance and financial performance. This alignment allows companies to focus on initiatives that will most probably have a high return on investment (ROI) and further the long-term growth goals. It makes sure that resources like capital, time, and human effort are invested in the projects that are not only profitable to the business but also sustainable. Moreover, it can assist businesses in remaining responsive and make fact-based financial changes on the fly, reducing risks, and leveraging new opportunities in a dynamic market.

Data and Financial Integration Tools and Technologies

To successfully combine the data-driven strategies with financial management, SMEs may utilize various tools and technologies aimed at simplifying and improving decision-making. ERP systems offer an integrated system of monitoring financials, managing resources, and aligning business operations. Through these systems, key performance indicators (KPIs) and financial metrics in departments can be monitored in real-time. Also, business intelligence (BI) software helps companies to derive actionable information out of data and present it as visual reports and dashboards that will give an overview of the performance of the organization. There are sophisticated technologies such as machine learning algorithms and predictive analytics that can be utilized to model various financial situations, predict cash flows, and simulate various strategic outcomes. These tools are beneficial because they allow SMEs to fine-tune their strategies through data-based forecasts, enabling them to be ahead of the market trends and make proactive decisions.

Challenges and Best Practices to implement

Although data and financial management integration has several advantages, SMEs encounter various difficulties in the process. Data quality is also another significant problem; false and unreliable data could lead to wrongful financial decisions and poor decision-making. There is also the possibility of delaying the integration process due to the untrained staff's inability to analyze complex data and transform it into viable financial plans. In addition to this, alignment of financial goals and strategies might be a challenge since it requires a harmonized understanding of the financial well-being and business strategy. To counter such hurdles, SMEs must invest in employee training in order to develop internal strengths in data analysis and financial management. It is also necessary to adopt flexible software that is capable of scaling with business needs. Moreover, data consistency across departments and recombining all the existing data sources into one system is essential to the preservation of the accuracy and relevance of insights. Finally, performance measures should consistently be reviewed and strategies adjusted to the new information to make sure that financial and strategic objectives are consistent and responsive to fluctuating market dynamics.

CONCLUSION

This paper highlights the critical importance of data-driven strategies in improving the strategic and financial management of science and technology-based SMEs. Employing state-of-the-art data analytics in their decision-making processes not only enables such SMEs to streamline the operational processes and get a better prediction of future trends but also provides deep, actionable insights that can lead to innovation, enhance profitability, and long-term growth. The real-time data analysis can assist SMEs in making an informed and agile decision, which will result in a higher efficiency of operation, reduce operational costs, and enhance the allocation of resources. This strategy enables businesses to constantly change to meet the market requirements, to be more effective in innovation, and to react to the new opportunities more precisely. In addition, by constantly measuring key performance indicators (KPIs), SMEs can detect inefficiencies, gauge risk, and streamline strategies, which ensures a competitive advantage that is essential in the modern, rapidly developing, and technology-focused business environment. Consequently, data-driven approaches are not only central to improving the daily business process but also assist SMEs in future-proofing their business and staying ahead of the curve in their respective sectors. The research future will entail diversification of data analytics in several functions, such as product development, marketing, and customer engagement. SMEs can enhance forecasting, financial planning, and customer insights with the development of machine learning, AI, and big data. With further development of technology and innovation, data-driven strategies will be instrumental in ensuring that SMEs can remain successful in the long run and be competitive in a fast-evolving global market.

REFERENCES

[1]   Tsiu SV, Ngobeni M, Mathabela L, Thango B. Applications and competitive advantages of data mining and business intelligence in SMEs performance: A systematic review. Businesses. 2025 May 7;5(2):22. https://doi.org/10.3390/businesses5020022

[2] Islam S, Hossain E, Rahman MS, Rahman MM, Khan SI, Ashik AA. Digital Transformation in SMEs: Unlocking Competitive Advantage through Business Intelligence and Data Analytics Adoption. Journal of Business and Management Studies. 2023 Dec 25;5(6):177-86. https://doi.org/10.32996/jbms.2023.5.6.14

[3] Vafaei-Zadeh A, Madhuri J, Hanifah H, Thurasamy R. The interactive effects of capabilities and data-driven culture on sustained competitive advantage. IEEE Transactions on Engineering Management. 2024 Jan 18;71:8444-58. https://doi.org/10.1109/TEM.2024.3355775

[4] Owusu J, Boateng PA, Yeboah N. Strategic Decision Support Systems for Enhancing Competitive Advantage in Small and Medium Enterprises. 2024 IEEE SmartBlock4Africa. 2024 Sep 30:1-0. https://doi.org/10.1109/SmartBlock4Africa61928.2024.10779545

[5] Kgakatsi M, Galeboe OP, Molelekwa KK, Thango BA. The impact of big data on SME performance: A systematic review. Businesses. 2024 Nov 14;4(4):632-95. https://doi.org/10.3390/businesses4040038

[6] Ramadan M, Shuqqo H, Qtaishat L, Asmar H, Salah B. Sustainable competitive advantage driven by big data analytics and innovation. Applied Sciences. 2020 Sep 28;10(19):6784. https://doi.org/10.3390/app10196784

[7] Magableh IK, Mahrouq MH, Ta'Amnha MA, Riyadh HA. The role of marketing artificial intelligence in enhancing sustainable financial performance of medium-sized enterprises through customer engagement and data-driven decision-making. Sustainability. 2024 Dec 23;16(24):11279. https://doi.org/10.3390/su162411279

[8] Lu H, Shaharudin MS. Role of digital transformation for sustainable competitive advantage of SMEs: a systematic literature review. Cogent Business & Management. 2024 Dec 31;11(1):2419489. https://doi.org/10.1080/23311975.2024.2419489

[9] Ragazou K, Passas I, Garefalakis A, Zopounidis C. Business intelligence model empowering SMEs to make better decisions and enhance their competitive advantage. Discover Analytics. 2023 Feb 6;1(1):2. https://doi.org/10.1007/s44257-022-00002-3

[10] Dimoso RL, Utonga D. A systematic review of digital technology adoption in small and medium-sized enterprises: implications for performance in developing countries. International Journal of Development and Management Review. 2024 Jul 5;19(1):58-71. https://dx.doi.org/10.4314/ijdmr.v19i1.4

[11] Tanjung FS. Data-driven decisions: Leveraging analytics for strategic marketing management. Equator Journal of Management and Entrepreneurship (EJME). 2024;12(4):322-31. https://doi.org/10.26418/ejme.v12i4.81935

[12] AL-Shboul MD. Fostering comparative advantage: the roles of data-driven competitive sustainability, green product innovation and green process innovation through moderated-mediation model. Business Process Management Journal. 2023 Oct 24;29(7):2228-54. https://doi.org/10.1108/BPMJ-06-2023-0484

[13] Arifin A, Misrah M, Mujahida S, Abubakar H. Mastery of financial accounting and market orientation: Driving competitive advantage in Indonesian SMEs. Asian Management and Business Review. 2025;5(2):279-96. https://doi.org/10.20885/AMBR.vol5.iss2.art3

[14] Akpe OE, Mgbame AC, Ogbuefi E, Abayomi AA, Adeyelu OO. Predictive analytics and scenario modeling for SME survival and competitiveness. Journal of Frontiers in Multidisciplinary Research. 2023 Jan;2(1):101-12. https://doi.org/10.54660/.IJFMR.2021.2.1.101-112

[15] Ramadan A, Alkhodary D, Alnawaiseh M, Jebreen K, Morshed A, Ahmad AB. Managerial competence and inventory management in SME financial performance: A Hungarian perspective. Journal of Statistics Applications & Probability. 2024;13(3):859-70. http://dx.doi.org/10.18576/jsap/130301

[16] Mushtaq N, Hussain F, Dad A, Rehman SU, Waseem M. Digital transformation and its impact on business performance in SMEs of Pakistan: an empirical study. The Asian Bulletin of Big Data Management. 2023;3(2):103-14.

[17] Žilka M, Kalender ZT, Lhota J, Kalina V, Pinto R. Tools to support managerial decision-building competencies in data driven decision making in manufacturing SMEs. Procedia Computer Science. 2024 Jan 1;232:416-25.

[18] Song J, Xia S, Vrontis D, Sukumar A, Liao B, Li Q, Tian K, Yao N. The source of SMEs' competitive performance in COVID-19: Matching big data analytics capability to business models. Information Systems Frontiers. 2022 Aug;24(4):1167-87. https://doi.org/10.1007/s10796-022-10287-0

[19] Hussain S, Masood K, Idrees F, Sohail A. Enhancing Competitive Advantage in SMEs through FinTech: The Mediating Roles of Technological Innovation and Financial Agility in Emerging Economy. Journal of Innovative Research in Management Sciences. 2025 Jun 30;6(2):45-64. https://doi.org/10.62270/jirms.v6i2.99

[20] Idris F, Susita D, Buchdadi AD. Enhancing the small medium enterprises competitive advantage through SMEs strategic alliances. Management Science Letters. 2020;10(9):2113-8. https://doi.org/10.5267/j.msl.2020.1.018