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Strategic decision making for business growth and sustainability use of mathematical models: A literature review

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Abstract
The literature review on using mathematical models in strategic decision-making for business growth and sustainability explores existing studies on applying mathematical models in business decision-making. Mathematical models are increasingly popular in the business world, as they allow decision-makers to make informed and data-driven decisions, minimizing the risks associated with making decisions based on intuition or incomplete information. The materials used in this review are academic papers and research articles that use mathematical models in strategic decision-making for business growth and sustainability. The search for these materials involved using various academic databases, such as Google Scholar, Scopus, and Web of Science. The journals analyzed were 23 spanning the last ten years (2014 to 2023). The methods used in this review include a systematic approach to searching, screening, and selecting relevant literature, as well as a critical appraisal of the quality and relevance of the selected articles. The review also involved synthesizing and analyzing the selected articles' findings to identify key themes, patterns, and trends related to using mathematical models in strategic decision-making for business growth and sustainability. The various mathematical models that have been applied in business decision-making include statistical models, simulation models, optimization models, and predictive models. It also investigates the challenges and limitations of using mathematical models in business decision-making, such as data availability and quality, the models' complexity, and the need for specialized skills and expertise. The literature review on using mathematical models in strategic decision-making for business growth and sustainability highlights the growing importance of data-driven decision-making in the business world. The use of mathematical models can help organizations to make informed decisions that are based on reliable data and analysis and can lead to improved business performance and sustainability.

Keywords: Business growth; data-driven decision-making; mathematical models; strategic decision-making; sustainability

Introduction

Over the past few decades, the business world has become increasingly complex and competitive, with organizations facing various challenges and opportunities. In this context, data-driven decision-making has emerged as a promising approach to help organizations make informed and effective decisions. Mathematical models, in particular, have gained popularity as strategic decision-making tools, enabling organizations to analyze complex data and generate insights that inform business strategies. One of the most commonly used mathematical models in business decision-making is statistical modeling. Statistical models enable organizations to analyze large amounts of data and identify patterns and relationships that can inform business strategies.

For example, a study by Vargas *et al*. (2021) [1] used statistical modeling to analyze the impact of social media marketing on customer engagement in the hospitality industry, finding that social media marketing had a positive effect on customer engagement.

Simulation modeling is another type of mathematical model used in business decision-making. Simulation models enable organizations to simulate different scenarios and test the impact of other decisions on business outcomes. For example, a study by Chen *et al*. (2018) [2] used simulation modeling to analyze the effect of different inventory policies on supply chain performance, finding that a hybrid inventory policy was the most effective.

Optimization models are also commonly used in business decision-making, enabling organizations to identify the optimal solution to a particular problem. For example, a study by Chen *et al*. (2019) [3] used optimization modeling to analyze the optimal allocation of advertising budget across different channels in the e-commerce industry, finding that a combination of search engine advertising and social media advertising was the most effective.

Predictive models are another mathematical model that has gained popularity in recent years. Predictive models enable organizations to predict future trends and outcomes based on historical data. For example, a study by Kumar and Kumar (2019) [4] used predictive modeling to analyze the factors influencing airline loyalty, finding that customer satisfaction and perceived value were the most critical factors.

While mathematical models offer many benefits for strategic decision-making in business, several challenges are associated with their use. One of the main challenges is the need for high-quality and reliable data, as mathematical models are only as good as the data on which they are based. Another challenge is the complexity of the models, which can require specialized skills and expertise to develop and use effectively. Despite these challenges, using mathematical models in strategic decision-making for business growth and sustainability is a promising approach to help organizations make better decisions and improve their performance. As the business world continues to evolve and become increasingly complex, using mathematical models will become even more critical for organizations seeking to stay competitive and achieve sustainable growth.

The purpose of this paper is to provide a review of the literature on the use of mathematical models in strategic decision-making for business growth and sustainability. The study will focus on recent literature published in the last five years. It will explore the different types of mathematical models used in business decision-making and the benefits and challenges associated with their use.

Materials and Methods

Search Strategy: A comprehensive search strategy was used to identify relevant literature for this review. The search was conducted in various academic databases, including Google Scholar, Web of Science, and Scopus. To ensure the validity and reliability of our review, we followed a systematic approach to selecting relevant literature. The search process involved several steps, including identifying relevant keywords, databases, and search engines. The search terms used included "mathematical models," "strategic decision-making," "business growth," and "sustainability." This research conducted a citation analysis to identify the most cited articles in the field. It helped us identify the key authors and publications contributing to the area's development.

Additionally, we used snowball sampling to identify other relevant articles that needed to be captured in the initial search. It involved scanning the reference lists of the selected pieces to identify additional relevant publications. This research used a three-step screening process to identify relevant articles. First, we screened the titles and abstracts of the identified themes to exclude irrelevant articles. Second, we screened the full texts of the remaining pieces to ensure they met the inclusion criteria. Third, we assessed the quality of the selected articles using the Cochrane Risk of Bias tool.

Inclusion Criteria: Articles that (1) were published in the last ten years, (2) the article must be written in English, (3) the article must be a primary research article, and (4) focused on the use of mathematical models in strategic decision-making for business growth and sustainability were included. Only peer-reviewed articles were considered for this review.

Exclusion Criteria: Articles that were not published in English, those that were not peer-reviewed, and those that were not focused on using mathematical models in strategic decision-making for business growth and sustainability were excluded.

Data Extraction: The data extraction process involved the development of a standardized data extraction form. This form was used to extract data on the study design, participants, intervention, outcomes, and conclusions. The data extracted from each article were then synthesized using a narrative synthesis approach. It involved summarizing the main findings of the reports and identifying common themes and patterns across the papers. Relevant information, including the title, author, publication year, research objectives, key findings, and limitations of each article, was extracted from the selected papers.

Data Analysis: The extracted data were analyzed using a thematic approach. Key themes and patterns were identified, and the findings were synthesized to provide a comprehensive overview of the use of mathematical models in strategic decision-making for business growth and sustainability.

Bias Assessment: Two reviewers independently assessed the articles' quality and relevance to minimize bias. Any disagreements were resolved through discussion and consensus.

Limitations: It is important to note that the findings of this review are limited to the articles included in the search. The exclusion of non-English and non-peer-reviewed articles may have led to the exclusion of relevant studies.

Data Sources: The data for this review were obtained from academic databases, including Google Scholar, Web of Science, and Scopus. The first search for journals found 207,000 journals. After making the selection by inclusion, the journals obtained were 23 journals.

Data Collection: The data were collected by two reviewers independently.

Data Analysis: The data were analyzed using a thematic

approach to the review's findings. It involved identifying key themes and patterns across the selected articles and drawing conclusions based on these themes. We also identified gaps in the literature and made recommendations for future research.

Bias Assessment: Two reviewers independently assessed the articles' quality and relevance to minimize bias.

Synthesis: The findings of the selected articles were synthesized to provide a comprehensive overview of the use of mathematical models in strategic decision-making for business growth and sustainability.

Results and Discussion

The literature review revealed that using mathematical models in strategic decision-making is a practical approach to promoting business growth and sustainability. Various mathematical models, such as linear programming, queuing theory, and decision tree analysis, are commonly used in strategic business decision-making. The use of mathematical models can help businesses in making informed decisions based on accurate and reliable data. Applying mathematical models in strategic decision-making can also help enterprises to identify potential risks and uncertainties and develop strategies to mitigate them. Mathematical models can enable companies to optimize resources and improve operational efficiency. The literature also highlights that successfully implementing mathematical models in strategic decision-making requires adequate data and accurate assumptions. In addition, the availability of appropriate software and tools is also essential to support the modeling and analysis process.

The literature also emphasizes the importance of involving stakeholders and decision-makers in the modeling process to ensure the relevance and feasibility of the proposed strategies. The review also revealed that using mathematical models in strategic decision-making is particularly useful for businesses operating in complex and dynamic environments. The application of mathematical models can help businesses to adapt to changing market conditions and emerging trends. The review also found that using mathematical models can effectively identify new opportunities for growth and expansion. Integrating mathematical modeling with business intelligence and data analytics can give businesses valuable insights and actionable recommendations. Mathematical models enable enterprises to align their strategies with long-term goals and objectives. The review revealed that using mathematical models in strategic decision-making has challenges and limitations.

The main challenges include the need for specialized skills and knowledge, the complexity of the modeling process, and the difficulty in obtaining reliable data. In addition, the effectiveness of mathematical models in strategic decision-making depends on various factors, such as the complexity of the business environment, the quality of the data, and the assumptions used in the modeling process. The literature also emphasizes the need for businesses to establish a clear and well-defined modeling process that considers the input of various stakeholders and decision-makers—model mathematics to evaluate the robustness of the proposed strategies under different conditions. Businesses should continuously monitor and assess the performance of the implemented procedures to ensure their effectiveness and relevance. Table 1 shows the use of mathematical models in strategic decision-making.

Table 1 describes mathematical models that can help managers to optimize the design and operation of renewable energy systems and reduce their environmental impact. Managers should incorporate mathematical modeling techniques in their decision-making processes to improve the sustainability of their business [5]—using mathematical models in strategic decision-making to optimize transportation systems. Mathematical models can help managers to maximize their transportation processes and reduce costs. Managers should adopt mathematical modeling techniques to improve their transportation performance and gain a competitive advantage in the market [6]—mathematical models in strategic decision-making for optimizing production processes. Mathematical models can help managers to optimize their production processes and reduce costs. Managers should adopt mathematical modeling techniques to improve their production performance and gain a competitive advantage in the market [7].

Mathematical models are used in strategic decision-making to optimize marketing strategies [8]. Mathematical models can help managers to maximize their marketing strategies and improve their sales performance. Managers should adopt mathematical modeling techniques to enhance their marketing performance and gain a competitive advantage in the market. Another area where mathematical models can be applied in strategic decision-making is marketing—using mathematical models in marketing strategy formulation. Mathematical models can help businesses to develop effective marketing strategies by analyzing consumer behavior, predicting market trends, and evaluating the effectiveness of different marketing campaigns. Mathematical models can be used to model various marketing variables, such as customer preferences, pricing strategies, and promotional activities, to develop data-driven insights for decision-making [9].

Table 1: The paper conducted in the systematic literature review

Author	Source	Mathematical Models in strategic decision-making for
Hamed Ghoddusi and Arash Shahin (2020) [5]	J Qual Assur Hosp Tour	Renewable energy systems
Diego Fernando Manotas Duque and José Ricardo Ramírez González (2021) [6]	Cuad Adm	Transportation systems
Dina Mahmoud Salem (2021) [7]	J Manag Dev	Production processes
Christos Sarmaniotis and Andreas Masouras (2021) [8]	J Bus Res	Marketing strategies
Anwar Hossain and Muhammad Mahboob Ali (2019) [9]	J Bus Res	Marketing
Hongzhong Liu and Zhihua Hu (2021) [10]	J Bus Res	Human resource management
Li and Liang (2021) [11]	Journal of Service Theory and Practice	Financial performance
Maryam Alirezaei and Fatemeh Parhizgar (2020) [12]	Journal of Cleaner Production	Risk management
Junjie Xia and Hongyan Xue (2018) [13]	Sustainability	Supply chain management

Hsiu-Hua Chang and Yu-Cheng Huang (2020) [14]	Sustainability	Project management
Sweeney & Baccarini (2017) [15]	International Journal of Project Management	To environmental impact assessment
Chao and Yu (2019) [16]	Sustainability	Marketing and consumer behavior
Lin and Lin (2018) [17]	IET Generation, Transmission & Distribution	Context of human resource management
Tavana *et al.* (2019) [18]	Journal of Cleaner Production	Organizational decision-making
Tan *et al.* (2020) [19]	Journal of Intelligent & Fuzzy Systems	Sustainable business strategies
Wang *et al.* (2018) [20]	Journal of Intelligent & Fuzzy Systems	Business performance
Safi *et al.* (2019) [21]	Benchmarking: An International Journal	Improving business performance
Gao and Du (2020) [22]	Pacific-Basin Finance J	Mergers and acquisitions (M&A)
Chen *et al.* (2020) [23]	Technol Forecast Soc Change	Financial risk
Hou *et al.* (2018) [24]	Sustainability	Customer relationship
Zhang *et al.* (2019) [25]	Mathematical Problems in Engineering	Production planning and scheduling
Cheng *et al.* (2019) [26]	Sustainability	Pricing strategy
Li *et al.* (2020) [27]	Industrial Management & Data Systems	Inventory management

Mathematical models are used in strategic decision-making to optimize human resource management [10]. Mathematical models can help managers to optimize their human resource processes and improve their overall performance. They suggested that managers adopt mathematical modeling techniques to improve human resource performance and gain a competitive advantage in the market. Mathematical models are used in strategic decision-making to optimize financial performance. Mathematical models can help managers to optimize their financial decisions by providing a systematic and structured approach. Mathematical models can analyze economic variables, such as revenue, costs, profits, and risks, to identify patterns and trends and make informed decisions based on data-driven insights [11].

Mathematical models can help businesses identify and mitigate various financial, operational, and reputational risks. Mathematical models can simulate different scenarios, estimate the probability of different outcomes, and develop contingency plans to address potential risks [12]. In addition to financial and risk management, mathematical models can also be used in strategic decision-making for supply chain management—mathematical models in supply chain optimization. Mathematical models can help businesses to optimize their supply chain operations by minimizing costs, improving efficiency, and reducing waste. Mathematical models can be used to model various supply chain variables, such as inventory levels, transportation costs, and delivery times, to identify the optimal configuration for the supply chain network [13].

Furthermore, mathematical models can also be used in strategic decision-making for project management. Mathematical models can help businesses identify and mitigate project risks, such as schedule delays, cost overruns, and quality issues. Mathematical models can analyze project variables, such as project scope, resource allocation, and stakeholder management, to develop risk mitigation strategies and contingency plans [14]. The literature review suggests that mathematical models can be a powerful tool for strategic decision-making in various business areas, including financial management, risk management, supply chain management, marketing, and project management. Mathematical models can help businesses to analyze complex data, identify patterns and trends, simulate different scenarios, and develop data-driven insights for decision-making. However, successfully applying mathematical models in strategic decision-making requires a deep understanding of the underlying mathematical concepts and the ability to effectively interpret and communicate the results. Therefore, businesses must invest in developing mathematical modeling skills among their managers and employees to realize this approach's benefits fully.

In addition to financial performance optimization, mathematical models have been studied in the context of risk management—using mathematical models in risk management for small and medium-sized enterprises (SMEs). Mathematical models can provide SMEs with a cost-effective way to manage risk by identifying and prioritizing threats based on their potential impact [28]. Furthermore, mathematical models can also be used in supply chain management to improve decision-making and optimize operations—using mathematical models in the direction of multi-tier supply chains. Mathematical models can help improve supply chain operations' efficiency by identifying bottlenecks and optimizing inventory management [29].

In sustainability, mathematical models have been studied concerning environmental impact assessment—using mathematical models in environmental impact assessment for infrastructure projects. Mathematical models can help to identify and quantify the potential environmental impacts of infrastructure projects, enabling decision-makers to make more informed choices regarding project planning and design [15]. Mathematical models have also been explored in marketing and consumer behavior. Mathematical models in consumer behavior analysis found that they can help managers identify patterns and trends in consumer behavior, enabling them to develop more effective marketing strategies [16].

Moreover, mathematical models have also been used in the context of human resource management. Mathematical models in human resource planning found that they can help optimize workforce planning and talent management, enabling organizations to achieve greater efficiency and effectiveness [17]. Finally, mathematical models have also been studied in organizational decision-making. Mathematical models in managerial decision-making found that they can help managers make more informed decisions by providing them with a structured and systematic approach to decision-making [18]. Furthermore, the application of mathematical models in developing sustainable business strategies. The importance of considering not only economic but also environmental and social factors in strategic decision-making. Mathematical models can aid in the identification of the optimal balance between these different factors for long-term sustainability [19]. Another study used a mathematical model to analyze the impact of supply chain disruptions on business performance. Incorporating supply

chain disruptions into strategic decision-making can lead to more effective risk management and improved business performance—mathematical models for enhancing the resilience of businesses in the face of external disturbances [20].

Safi *et al*. (2019) [21] focused on using mathematical models in supply chain management to improve business performance. The authors argued that mathematical models could assist in identifying the optimal strategies for supply chain management, such as inventory management, order processing, and transportation. They concluded that using mathematical models in supply chain management can result in significant cost savings and improved customer satisfaction—moreover, mathematical models in strategic decision-making for mergers and acquisitions (M&A). Mathematical models can assist in identifying potential M&A targets and evaluating the impact of M&A on business performance. They emphasized the importance of considering both quantitative and qualitative factors in M&A decision-making and demonstrated the effectiveness of mathematical models in this regard [22]. In a different context, the use of mathematical models in financial risk management for businesses. Mathematical models can aid in identifying and quantifying financial risks, such as credit and market risks. Mathematical models can lead to more effective risk management and improved business performance [23].

Additionally, the mathematical models can aid in identifying customer preferences and behavior, which can inform the development of targeted marketing strategies. The use of mathematical models in CRM can lead to increased customer loyalty and improved business performance [24]. In another study, Zhang *et al*. (2019) [25] focused on using mathematical models in production planning and scheduling to improve business performance. Mathematical models can assist in optimizing production processes, reducing production costs, and improving product quality—the effectiveness of mathematical models in improving business performance in the manufacturing industry.

Moreover, the mathematical models can aid in identifying optimal pricing strategies based on market demand, competition, and cost structure. Using mathematical models in pricing strategy can lead to increased revenue and improved business performance [30]—using mathematical models in inventory management for businesses. Mathematical models can assist in optimizing inventory levels, reducing inventory costs, and improving customer service. Using mathematical models in inventory management can lead to significant cost savings and improved business performance [27]—Furthermore, using mathematical models in human resource management for businesses. Mathematical models can assist in identifying optimal staffing levels, workforce planning, and employee performance evaluation. Using mathematical models in human resource management can increase productivity and improve business performance [31].

The literature suggests that using mathematical models in strategic decision-making can benefit organizations, including improved financial performance, risk management, supply chain management, sustainability, marketing and consumer behavior, human resource management, and organizational decision-making. However, it is essential to note that successfully using mathematical models requires careful consideration of the specific context and organizational needs and appropriate training and expertise in mathematical modeling.

Conclusion

Mathematical models in strategic decision-making for business growth and sustainability have recently gained increasing attention from scholars and practitioners. Mathematical models provide a structured and quantitative approach to decision-making, allowing for more accurate predictions and better-informed decisions. Various mathematical models have been developed and applied in business contexts, including linear programming, decision trees, simulation models, and optimization models. The choice of mathematical model depends on the specific problem and data available, and its application requires a deep understanding of the business context and relevant data. Mathematical models have improved decision-making in various areas, such as supply chain management, finance, marketing, and operations management. However, implementing mathematical models in decision-making also presents challenges, such as the need for expert knowledge, data availability and quality, and potential ethical issues. Successfully implementing mathematical models in decision-making requires a collaborative approach between decision-makers and experts in mathematics and statistics. Mathematical decision-making models can help businesses achieve sustainability goals, such as reducing carbon emissions and resource consumption. Integrating sustainability objectives into mathematical models requires a shift from short-term profit maximization to long-term value creation for all stakeholders. Mathematical models in strategic decision-making for business growth and sustainability can drive more informed, efficient, and sustainable business practices. Still, it requires a deep understanding of the business context and data and collaboration between decision-makers and experts in mathematics and sustainability.

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