Review of Strategic Sourcing in Engineering: Optimization Techniques and Cost Management

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Abstract

Strategic sourcing plays a critical role in the engineering sector, where the optimization of procurement processes and effective cost management are essential for enhancing project success and maintaining competitiveness. This narrative review explores the intersection of optimization techniques and cost management strategies within strategic sourcing in engineering. The review synthesizes existing literature on various optimization methods, including linear programming, mixed-integer programming, and heuristic approaches, highlighting their application in supplier selection and resource allocation. Additionally, the review examines cost management techniques such as total cost of ownership (TCO), activity-based costing (ABC), and cost modeling, discussing their integration with optimization methods to improve sourcing decisions. The challenges associated with implementing these strategies, particularly in complex engineering projects, are also addressed. The findings underscore the importance of a holistic approach to strategic sourcing, where optimization and cost management are integrated to achieve more effective and efficient procurement outcomes. The review concludes by identifying gaps in the literature and suggesting directions for future research, particularly in the application of emerging technologies in strategic sourcing.

Keywords: Strategic sourcing, engineering, optimization techniques, cost management, supplier selection, total cost of ownership (TCO), activity-based costing (ABC).

Introduction

Strategic sourcing, particularly within the engineering sector, plays a pivotal role in enhancing the efficiency and competitiveness of organizations. It involves a comprehensive and systematic process of evaluating, selecting, and managing suppliers in alignment with a company's strategic objectives. In the context of engineering, strategic sourcing is not merely a procurement function; it is a critical element of the overall project management and operational strategy. Engineering projects often involve complex, high-value components, and materials, making the sourcing process a key determinant of both project success and overall organizational performance (Handfield, 2019).

Optimization techniques and cost management are integral to strategic sourcing in engineering. Optimization techniques, which include both mathematical and heuristic methods, are employed to identify the most efficient and cost-effective sourcing strategies. These techniques enable organizations to make informed decisions by analyzing vast datasets and considering various constraints such as budget, time, and resource availability. For instance, linear programming and mixed-integer programming are commonly used to optimize supplier selection and inventory management, while heuristic methods like genetic algorithms are applied in scenarios where traditional optimization methods may be computationally expensive or infeasible (Zsidisin & Hartley, 2020).

Cost management, on the other hand, focuses on minimizing the total cost of ownership (TCO) while maintaining or improving the quality and reliability of sourced components. In the highly competitive and globalized engineering industry, effective cost management is crucial. Engineering projects are often subject to tight budgets and stringent deadlines, making it essential to manage costs meticulously without compromising on quality. Strategic sourcing that incorporates robust cost management practices ensures that organizations can achieve significant cost savings, improve profit margins, and enhance their competitive advantage in the market (Monczka et al., 2020).

The relevance of strategic sourcing, optimization techniques, and cost management in today's engineering environment cannot be overstated. The globalization of supply chains, increasing complexity of engineering projects, and rapid technological advancements have made strategic sourcing a critical competency for engineering firms. Companies are now required to source from a global supplier base, manage risks associated with supply chain disruptions, and navigate complex regulatory environments. Moreover, the shift towards sustainable and ethical sourcing practices has added another layer of complexity to the sourcing process. As a result, the ability to optimize sourcing strategies and manage costs effectively is now more important than ever for engineering organizations aiming to remain competitive in the global marketplace (Christopher, 2016).

The primary objective of this review is to provide a comprehensive analysis of strategic sourcing in the engineering sector, with a particular focus on optimization techniques and cost management strategies. This review aims to synthesize existing literature on the subject, highlighting the key concepts, methodologies, and challenges associated with strategic sourcing in engineering. By examining various optimization techniques and cost management strategies, the review seeks to identify best practices that can be applied to enhance sourcing efficiency and effectiveness in engineering projects.

Methodology

The literature selection process began with an extensive search across multiple academic databases, including but not limited to Scopus, Web of Science, IEEE Xplore, and Google Scholar. The search was guided by key terms such as "strategic sourcing," "optimization techniques," "cost management," "engineering procurement," and "supplier selection." To ensure a robust and relevant selection of sources, the search focused on peer-reviewed journal articles, conference papers, and significant industry reports published within the last two decades. Older sources were included only if they were seminal works that provided foundational theories or concepts still relevant today.

Inclusion criteria for the literature encompassed studies that directly addressed strategic sourcing in the context of engineering, with a particular emphasis on optimization techniques and cost management. Articles that provided empirical data, case studies, or theoretical models related to these topics were prioritized. Exclusion criteria involved studies that were too narrowly focused on non-engineering industries, or those that did not provide substantial insights into optimization or cost management aspects of strategic sourcing.

Once the literature was collected, a descriptive analysis method was employed to categorize and summarize the findings. This method involved systematically reviewing each selected source, identifying key themes, methodologies, and outcomes related to strategic sourcing in engineering. The analysis focused on how various optimization techniques have been applied in engineering procurement processes, the effectiveness of these techniques in different contexts, and the role of cost management strategies in achieving sourcing efficiency. This approach allowed for the identification of trends, common challenges, and successful strategies within the existing body of knowledge.

In synthesizing the literature, the review aimed to draw connections between different studies, highlighting areas of consensus as well as debates and gaps in the literature. Special attention was given to the practical implications of the findings, considering how the theoretical models and optimization techniques discussed in the literature can be applied in real-world engineering scenarios. Additionally, the review explored the integration of cost management strategies with optimization techniques, analyzing how these combined approaches contribute to more effective and efficient strategic sourcing outcomes.

Strategic Sourcing in Engineering: An Overview

Strategic sourcing, in its most basic form, involves the process of identifying, evaluating, and engaging suppliers to acquire goods and services that are vital to an organization's operations. However, in the engineering context, strategic sourcing extends beyond mere procurement; it is a critical component of an organization's overall strategic framework. It encompasses a range of activities, including market research, supplier relationship management, risk management, and the continuous assessment of sourcing strategies to align with the organization's long-term goals. Strategic sourcing is not a one-time activity but an ongoing process that evolves with changes in market conditions, technological advancements, and organizational needs (Monczka et al., 2020).

In engineering, where projects are often complex and resource-intensive, strategic sourcing is crucial. It involves the careful selection of suppliers who can meet the technical specifications, quality standards, and delivery schedules required for engineering projects. The process also includes negotiating contracts, managing supplier performance, and ensuring that sourcing decisions contribute to the overall

success of the project. Effective strategic sourcing in engineering requires a deep understanding of both the technical and commercial aspects of the products and services being sourced, as well as the ability to navigate the complexities of global supply chains (Handfield, 2019).

The importance of strategic sourcing in engineering cannot be overstated. It directly impacts the cost, quality, and timeliness of project deliverables. For example, in large-scale engineering projects such as infrastructure development, the sourcing of key materials like steel, concrete, and specialized machinery can account for a significant portion of the project's budget. Strategic sourcing ensures that these materials are procured at the best possible price without compromising on quality, thereby contributing to the overall cost-effectiveness of the project (Zsidisin & Hartley, 2020).

Moreover, strategic sourcing in engineering plays a vital role in risk management. Engineering projects are often subject to a range of risks, including supply chain disruptions, cost overruns, and quality issues. By adopting a strategic approach to sourcing, organizations can mitigate these risks by diversifying their supplier base, establishing long-term partnerships with key suppliers, and implementing robust supplier performance monitoring systems. For instance, during the COVID-19 pandemic, many engineering firms that had previously invested in strategic sourcing were able to navigate supply chain disruptions more effectively than those that had not (Ivanov & Dolgui, 2020).

Strategic sourcing also contributes to innovation in engineering projects. By collaborating closely with suppliers, engineering firms can gain access to new technologies and innovative solutions that can enhance project outcomes. Suppliers often possess specialized knowledge and capabilities that can be leveraged to improve product design, reduce costs, and accelerate time-to-market. This collaborative approach to sourcing fosters innovation and helps engineering firms maintain a competitive edge in the market (Monczka et al., 2020).

Despite its importance, strategic sourcing in engineering is fraught with challenges. One of the most significant challenges is the complexity of engineering projects. These projects often involve a large number of components, each with its own set of technical specifications and sourcing requirements. Managing the sourcing process for such projects requires a high level of expertise and coordination across different functions within the organization (Handfield, 2019).

Another challenge is the management of supply chain risks. Engineering projects are often subject to tight schedules and budgets, making them vulnerable to supply chain disruptions. For example, delays in the delivery of critical components can lead to project delays and cost overruns. Managing these risks requires a proactive approach to supplier selection and relationship management, as well as the implementation of contingency plans to address potential disruptions (Ivanov & Dolgui, 2020).

Cost management is another significant challenge in strategic sourcing. Engineering projects are often subject to budget constraints, making it essential to manage costs effectively throughout the sourcing process. However, cost management is not always straightforward, as it involves balancing the need to minimize costs with the need to maintain quality and meet project timelines. This requires careful planning and the use of sophisticated cost management tools and techniques (Zsidisin & Hartley, 2020).

Optimization Techniques in Strategic Sourcing

Optimization techniques are essential tools in strategic sourcing, enabling organizations to make data-driven decisions that maximize efficiency and minimize costs. These techniques are particularly

important in engineering, where sourcing decisions can have a significant impact on project outcomes. Optimization involves the application of mathematical models and algorithms to identify the best possible solution from a set of feasible alternatives. In the context of strategic sourcing, optimization techniques are used to select suppliers, determine order quantities, and allocate resources in a way that minimizes costs and meets project requirements (Kumar et al., 2018).

There are various types of optimization techniques used in strategic sourcing, including mathematical programming, heuristic methods, and metaheuristic algorithms. Each of these techniques has its strengths and weaknesses, and the choice of technique depends on the specific characteristics of the sourcing problem at hand. For example, mathematical programming techniques such as linear programming and mixed-integer programming are well-suited for problems that can be formulated as linear or mixed-integer optimization models. These techniques are highly effective for solving large-scale sourcing problems, where the objective is to minimize costs or maximize efficiency subject to a set of constraints (Kumar et al., 2018).

Heuristic methods, on the other hand, are designed to find good solutions to complex optimization problems in a relatively short amount of time. These methods do not guarantee an optimal solution, but they are often used in practice because they can provide satisfactory solutions to problems that are too complex or time-consuming to solve exactly. Examples of heuristic methods used in strategic sourcing include genetic algorithms, simulated annealing, and tabu search. These methods are particularly useful for solving sourcing problems that involve a large number of variables and constraints, such as the selection of suppliers in a global supply chain (Govindan et al., 2020).

Mathematical approaches to optimization in strategic sourcing are based on the formulation of the sourcing problem as a mathematical model, typically a linear or mixed-integer programming model. In these models, the objective function represents the total cost or benefit associated with a particular sourcing decision, while the constraints represent the technical, operational, and financial requirements that must be met. The solution to the model is the set of decision variables that minimize or maximize the objective function while satisfying all the constraints (Kumar et al., 2018).

Linear programming is one of the most widely used mathematical optimization techniques in strategic sourcing. It is particularly useful for problems that involve continuous decision variables, such as the allocation of resources or the determination of order quantities. Mixed-integer programming, on the other hand, is used for problems that involve both continuous and discrete decision variables, such as the selection of suppliers or the scheduling of deliveries. These techniques have been successfully applied in a wide range of engineering sourcing problems, from the optimization of supply chain networks to the allocation of resources in complex projects (Kumar et al., 2018).

Heuristic approaches to optimization, such as genetic algorithms and simulated annealing, are based on the idea of searching for good solutions in a large and complex solution space. These methods are particularly useful for solving sourcing problems that are difficult to model mathematically or that involve a large number of variables and constraints. Genetic algorithms, for example, are inspired by the principles of natural selection and evolution. They work by iteratively improving a population of candidate solutions through processes such as selection, crossover, and mutation. Simulated annealing, on the other hand, is inspired by the physical process of annealing in metals, where the temperature of the material is

gradually reduced to allow it to settle into a low-energy state. Both of these methods have been successfully applied in strategic sourcing to find good solutions to complex optimization problems (Govindan et al., 2020).

Supplier selection is one of the most critical aspects of strategic sourcing, and optimization techniques play a key role in this process. The goal of supplier selection is to identify the suppliers that can provide the required goods and services at the best possible price, while also meeting quality, delivery, and other performance criteria. Optimization techniques are used to evaluate and compare different suppliers based on a set of criteria, such as cost, quality, and delivery time. These techniques can also be used to determine the optimal allocation of orders among multiple suppliers, taking into account factors such as supplier capacity, lead time, and risk (Zsidisin & Hartley, 2020).

Mathematical programming techniques, such as linear and mixed-integer programming, are commonly used in supplier selection to solve multi-criteria decision-making problems. These techniques allow decision-makers to consider multiple objectives and constraints simultaneously, and to find the optimal trade-off between different criteria. For example, a company might use linear programming to minimize the total cost of sourcing while also ensuring that the selected suppliers meet quality and delivery requirements. In more complex scenarios, mixed-integer programming can be used to model the supplier selection problem as a mixed-integer optimization problem, where some of the decision variables are binary (representing the selection or non-selection of a supplier) and others are continuous (representing the quantity to be ordered from each supplier) (Kumar et al., 2018).

Heuristic and metaheuristic methods, such as genetic algorithms and simulated annealing, are also widely used in supplier selection. These methods are particularly useful when the supplier selection problem involves a large number of variables and constraints, or when the decision-making process is highly complex. For example, genetic algorithms can be used to search for the optimal combination of suppliers that minimize the total cost of sourcing while also meeting quality and delivery requirements. Simulated annealing, on the other hand, can be used to find good solutions to supplier selection problems that are difficult to solve using traditional optimization methods (Govindan et al., 2020).

There are numerous case studies and examples that illustrate the successful application of optimization techniques in strategic sourcing. For instance, a study by Kumar et al. (2018) demonstrated the use of mixed-integer programming to optimize the supplier selection process for a large manufacturing company. The company was able to reduce its total sourcing costs by 15% while also improving the quality and reliability of its suppliers. Another study by Govindan et al. (2020) highlighted the use of genetic algorithms to optimize the sourcing of raw materials for a chemical engineering company. The company was able to achieve significant cost savings and improve the efficiency of its supply chain by using genetic algorithms to identify the optimal combination of suppliers.

In another example, Zsidisin and Hartley (2020) described the use of simulated annealing to optimize the sourcing of components for an aerospace engineering project. The project involved sourcing a large number of components from multiple suppliers, each with its own set of technical specifications and delivery requirements. By using simulated annealing, the project team was able to identify the optimal combination of suppliers that minimized the total cost of sourcing while also meeting the project's

technical and delivery requirements. This approach allowed the project team to reduce its sourcing costs by 10% and complete the project on time and within budget.

When comparing different optimization techniques, it is important to consider the specific characteristics of the sourcing problem at hand. Mathematical programming techniques, such as linear and mixed-integer programming, are highly effective for solving sourcing problems that can be modeled mathematically and that involve a relatively small number of variables and constraints. These techniques provide exact solutions and are well-suited for problems that require a high degree of accuracy and precision (Kumar et al., 2018).

Heuristic and metaheuristic methods, on the other hand, are more flexible and can be applied to a wider range of sourcing problems. These methods are particularly useful for solving complex optimization problems that are difficult to model mathematically or that involve a large number of variables and constraints. While these methods do not guarantee an optimal solution, they can often find good solutions in a relatively short amount of time. This makes them well-suited for sourcing problems that require a quick decision or that involve a high degree of uncertainty (Govindan et al., 2020).

In practice, the choice of optimization technique often depends on the specific requirements of the sourcing problem, as well as the availability of data and computational resources. In some cases, a combination of techniques may be used to achieve the best possible results. For example, a company might use linear programming to solve the initial supplier selection problem and then use genetic algorithms to fine-tune the solution based on additional criteria, such as supplier capacity or risk (Zsidisin & Hartley, 2020).

Cost Management in Strategic Sourcing

Cost management is a fundamental component of strategic sourcing, particularly in the engineering sector where projects are often capital-intensive and involve significant financial investments. Effective cost management ensures that organizations can achieve their procurement objectives within budgetary constraints while maintaining the desired quality and performance levels. In the context of strategic sourcing, cost management is not merely about minimizing expenses but about optimizing the entire cost structure associated with sourcing decisions. This includes considering both direct costs, such as the price of goods and services, and indirect costs, such as logistics, inventory carrying costs, and potential risks associated with supplier reliability and market fluctuations (Monczka et al., 2020).

The significance of cost management in strategic sourcing is further amplified in today's competitive and globalized engineering environment. Companies are under constant pressure to reduce costs while simultaneously improving the quality and reliability of their products and services. As a result, strategic sourcing decisions that incorporate robust cost management practices can provide a significant competitive advantage. For example, by effectively managing costs, companies can improve their profit margins, invest in innovation, and respond more flexibly to changes in market conditions (Handfield, 2019). Moreover, strategic sourcing that integrates cost management helps organizations mitigate risks related to cost overruns and ensures that they can deliver projects on time and within budget.

Several cost management strategies have been developed to enhance cost control in strategic sourcing. One of the most widely used techniques is cost modeling, which involves the construction of detailed cost breakdowns for products or services. Cost modeling allows companies to understand the cost

drivers associated with different components of a product or service, enabling more informed sourcing decisions. For instance, cost modeling can help identify opportunities for cost reduction by highlighting areas where materials or processes can be optimized or where alternative suppliers may offer better value (Ellram & Siferd, 1998).

Total cost of ownership (TCO) is another critical cost management strategy in strategic sourcing. TCO considers not only the purchase price of a product or service but also all associated costs over its entire lifecycle, including maintenance, operation, disposal, and potential risks. By adopting a TCO approach, organizations can make more holistic sourcing decisions that reflect the true cost of ownership, rather than simply focusing on the initial purchase price. This approach is particularly relevant in engineering projects where the long-term costs of equipment and materials can significantly impact the overall project budget (Ferrin & Plank, 2002).

Activity-based costing (ABC) is a further method used to enhance cost management in strategic sourcing. ABC assigns costs to specific activities based on their consumption of resources, providing a more accurate picture of the costs associated with different sourcing activities. For example, ABC can help organizations identify which suppliers or procurement processes are consuming the most resources, allowing them to target cost reduction efforts more effectively. This technique is especially useful in complex engineering projects where traditional costing methods may not accurately capture the cost dynamics of different sourcing activities (Kaplan & Anderson, 2007).

Cost management techniques are most effective when integrated with optimization methods in strategic sourcing. Optimization techniques, such as linear programming or genetic algorithms, can be used to identify the most cost-effective sourcing strategies by considering various constraints and objectives. When combined with cost management strategies like TCO or ABC, optimization methods enable organizations to make sourcing decisions that not only minimize costs but also optimize the overall value derived from the sourcing process (Kumar et al., 2018).

For example, in supplier selection, an optimization model that integrates TCO can help identify the supplier that offers the best value over the product's lifecycle, rather than simply the lowest initial cost. Similarly, by incorporating ABC into optimization models, organizations can more accurately allocate resources to different sourcing activities, ensuring that cost management efforts are aligned with the overall strategic objectives of the organization. This integration of cost management with optimization leads to more informed and effective sourcing decisions, ultimately enhancing the efficiency and competitiveness of engineering projects (Govindan et al., 2020).

Implementing cost management strategies in strategic sourcing is not without challenges. One of the primary challenges is the complexity of accurately capturing and analyzing costs, particularly in large and multifaceted engineering projects. Traditional costing methods may not adequately reflect the true costs associated with different sourcing decisions, leading to suboptimal outcomes. This is where advanced costing techniques like ABC and TCO can be particularly valuable, although their implementation can be resource-intensive and require specialized expertise (Kaplan & Anderson, 2007).

Another challenge is the dynamic nature of costs in global supply chains. Prices for raw materials, labor, and transportation can fluctuate due to various factors, including market conditions, geopolitical events, and currency exchange rates. Managing these fluctuations requires a proactive approach to cost

management, such as the use of dynamic cost models and real-time data analysis. Organizations must also be prepared to adjust their sourcing strategies in response to changing cost conditions, which can be challenging in the context of long-term contracts or established supplier relationships (Ivanov & Dolgui, 2020).

To address these challenges, organizations can adopt several solutions. One approach is to invest in advanced analytics and data management tools that enable real-time monitoring and analysis of costs across the supply chain. These tools can provide valuable insights into cost trends and help organizations make more agile and informed sourcing decisions. Additionally, organizations can develop strategic partnerships with key suppliers to share cost information and collaborate on cost reduction initiatives. By fostering closer relationships with suppliers, companies can gain a better understanding of the cost drivers in their supply chain and work together to achieve mutual cost management goals (Zsidisin & Hartley, 2020).

The engineering industry offers several examples of how effective cost management in strategic sourcing can lead to successful outcomes. For instance, a case study of a large aerospace manufacturer demonstrated the use of TCO in selecting suppliers for critical components. By considering the total cost of ownership, including maintenance and operational costs, the company was able to identify suppliers that offered the best long-term value. This approach not only reduced the overall cost of the project but also improved the reliability and performance of the final product (Ferrin & Plank, 2002).

Another example comes from the automotive industry, where a leading manufacturer used ABC to optimize its procurement processes. By accurately identifying the costs associated with different sourcing activities, the company was able to streamline its supplier base and reduce overhead costs. This resulted in significant cost savings, which were reinvested in product development and innovation, further enhancing the company's competitive position in the market (Kaplan & Anderson, 2007).

These examples highlight the importance of integrating cost management strategies into strategic sourcing decisions in the engineering industry. By adopting techniques like TCO and ABC and integrating them with optimization methods, organizations can achieve more cost-effective and efficient sourcing outcomes, ultimately contributing to the success of their projects and their overall business objectives (Monczka et al., 2020).

Discussion

The review of strategic sourcing in engineering, with a focus on optimization techniques and cost management, reveals several key insights. Optimization techniques, such as linear programming, mixed-integer programming, and heuristic methods, play a crucial role in enhancing the efficiency and effectiveness of sourcing decisions. These techniques enable organizations to systematically analyze and optimize sourcing strategies, considering various constraints and objectives. When combined with cost management strategies like total cost of ownership (TCO) and activity-based costing (ABC), optimization methods provide a comprehensive approach to managing costs while maximizing value in the sourcing process (Kumar et al., 2018).

Cost management, as highlighted in the review, is essential for achieving competitive advantage in the engineering industry. The use of advanced cost management techniques allows organizations to gain a deeper understanding of cost drivers, make more informed sourcing decisions, and improve overall

project outcomes. However, the integration of cost management with optimization techniques is crucial for realizing the full benefits of these strategies. By aligning cost management efforts with optimization models, organizations can ensure that their sourcing decisions are both cost-effective and strategically sound (Govindan et al., 2020).

The findings of this review have significant implications for engineering practice. First, engineering professionals must recognize the importance of incorporating advanced optimization techniques into their strategic sourcing processes. These techniques not only enhance decision-making but also enable organizations to navigate the complexities of global supply chains and manage risks more effectively. Additionally, the integration of cost management strategies with optimization models should be a priority for engineering firms seeking to improve their sourcing efficiency and reduce costs (Monczka et al., 2020).

Moreover, the review underscores the need for engineering professionals to adopt a holistic approach to cost management. Rather than focusing solely on initial purchase prices, organizations should consider the total cost of ownership and other long-term costs associated with their sourcing decisions. This approach will enable them to achieve more sustainable and cost-effective outcomes in their projects. Engineering firms that invest in the necessary tools and expertise to implement these strategies will be better positioned to compete in the increasingly complex and competitive global market (Handfield, 2019).

Despite the comprehensive nature of the existing literature on strategic sourcing, optimization techniques, and cost management, several gaps remain. One of the primary gaps is the need for more empirical studies that demonstrate the practical application of these techniques in real-world engineering projects. While there is a wealth of theoretical research, more case studies and industry-specific examples are needed to provide practical guidance for engineering professionals. Additionally, further research is needed to explore the integration of emerging technologies, such as artificial intelligence and machine learning, into optimization and cost management strategies (Kumar et al., 2018).

Another gap in the literature is the need for more research on the challenges and barriers to implementing these strategies in different engineering contexts. While the benefits of optimization and cost management are well-documented, less is known about the practical challenges organizations face when trying to implement these strategies, particularly in complex or resource-constrained environments. Addressing these gaps will require a combination of theoretical and empirical research that explores the practical application of these strategies in diverse engineering settings (Govindan et al., 2020).

Looking ahead, several trends are likely to shape the future of strategic sourcing in engineering. One of the most significant trends is the increasing use of digital technologies, such as artificial intelligence, big data analytics, and blockchain, in the sourcing process. These technologies have the potential to enhance the accuracy and efficiency of optimization models, provide real-time insights into cost drivers, and improve the transparency and traceability of supply chains. As these technologies continue to evolve, they will likely become integral components of strategic sourcing and cost management strategies in the engineering industry (Ivanov & Dolgui, 2020).

Another future trend is the growing emphasis on sustainability and ethical sourcing. As organizations face increasing pressure to reduce their environmental impact and adhere to ethical standards, strategic sourcing decisions will need to incorporate sustainability criteria. This will require the

development of new optimization models and cost management techniques that take into account not only financial costs but also environmental and social impacts. Engineering firms that can successfully integrate sustainability into their strategic sourcing practices will be better positioned to meet the demands of customers, regulators, and other stakeholders (Christopher, 2016).

Conclusion

This review has highlighted the critical role of strategic sourcing in the engineering industry, with a particular focus on the importance of optimization techniques and cost management strategies. Optimization techniques, such as linear programming and genetic algorithms, provide powerful tools for enhancing the efficiency and effectiveness of sourcing decisions. When integrated with cost management strategies like total cost of ownership and activity-based costing, these techniques enable organizations to achieve more cost-effective and strategically aligned sourcing outcomes. The review also identified several challenges in implementing these strategies, including the complexity of accurately capturing costs and the dynamic nature of global supply chains (Monczka et al., 2020).

The review contributes to the field of strategic sourcing in engineering by providing a comprehensive synthesis of existing literature on optimization techniques and cost management strategies. It offers practical insights into how these strategies can be applied to enhance sourcing efficiency and reduce costs in engineering projects. Additionally, the review identifies gaps in the literature and suggests areas for future research, particularly in the integration of emerging technologies and the practical challenges of implementing these strategies in different engineering contexts (Govindan et al., 2020).

In conclusion, strategic sourcing, when supported by robust optimization and cost management strategies, is a critical enabler of success in the engineering industry. As the global market becomes increasingly competitive and complex, engineering firms must continue to innovate and refine their sourcing practices to remain competitive. Ongoing research and innovation in optimization techniques and cost management will be essential to meet the evolving demands of the industry and to address the challenges posed by new technologies and sustainability requirements. By staying at the forefront of these developments, engineering professionals can ensure that their organizations are well-positioned to succeed in the dynamic and challenging environment of the future (Handfield, 2019).

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