OPTIMISING ENERGY EFFICIENCY THROUGH EFFECTIVE SUPPLY CHAIN MANAGEMENT: A COMPARATIVE STUDY

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Highlights

Optimising Energy Efficiency Through Effective Supply Chain Management.

Abstract

Energy Efficiency (EE) is a crucial resource for social and financial development, benefiting everyone through EE developers in society. Encouraging energy problem alignment with corporate company goals increases productivity, profitability, quality, and cost reductions. EE is an essential benefit for organizations, not merely a minor concern. Most companies, particularly Small and Medium Enterprises (SMEs), need help adopting EE measures and even encounter opposition. Funding and awareness (particularly of life cycle cost impacts) are the biggest obstacles. One way weaker organizations might overcome such constraints and improve EE is from the Supply Chain (SC) perspective. Since most EE studies and practical strategies concentrate on single-firm energy usage, this article examines peer-reviewed journal articles on EE incorporation in SC development and oversight to identify research needs. Several literature evaluations have focused on sustainability or Supply Chain Management (SCM), but none have addressed EE. First, this article explains how energy usage in SCM improves systemic EE. Then, a study technique is developed, and the selected publications are examined and classed by their methodologies.

Keywords

supply chain management; energy efficiency; study; optimisation.

Background to Supply Chain Management

Despite many nations' excellent Energy Efficiency (EE), global energy use rose from 3.7k million metric tons of oil or its equivalent in 1960 to 14k [1]. As one of the largest energy consumers worldwide, the manufacturing industry has become increasingly crucial to authorities to maintain ecological sustainability. Many organizations began energy audits over a decade ago to assess energy use all through their manufacturing procedures, particular processes, or a single piece of machinery. These inspections showed several ways to increase industrial EE, depending on system limits. Improving EE helps a corporation make products, convert energy, etc., employing less power. Due to consumer consciousness of the environment, EE increases the efficiency of a company and produces reduced expenses and income. These predicted gains are possible due to present and potential policies and circumstances. The main factors that affect supply chain management are shown in Fig. 1.

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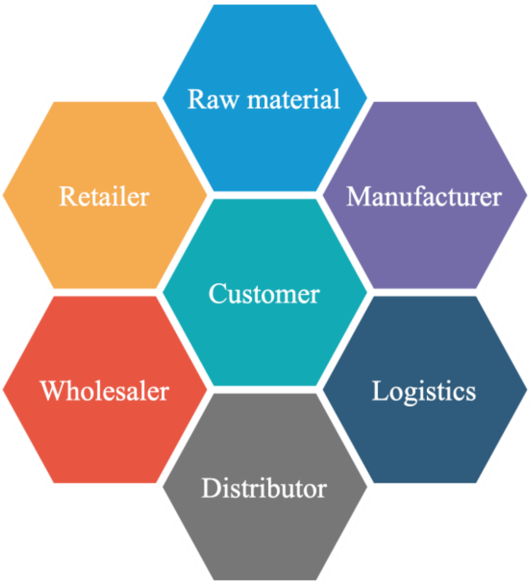

Fig. 1. Main factors affecting supply chain management

Supply Chain Management (SCM) contains vertical dynamic ties between the company, customers, and providers and horizontal connections among suppliers [2]. This definition suggests that these supply links are employed as a theoretical framework for the organized evaluation and are more relevant to the study's gaps determined, emphasizing the operational viewpoint of management. Suppliers and clients have upward and downward links in the Supply Chain (SC) [3]. Based on these criteria, the organized evaluation analyzes these supply linkages and focuses on the study's limitations highlighted from an operations administration viewpoint.

The remaining sections are organized as follows: section 2 covers the background and the chosen articles for examination. Section 3 explores the study topics related to supply chain management with optimized energy efficiency. Section 4 presents the study results.

Background and Literature Survey

The content assessment of recent articles seeks a more complete examination of SCM-EE and sustainable development studies [4]. The literature found five key issue areas:

- The primary drivers and challenges to EE and sustainable development activities in SCs are outlined.
- EE and sustainable development initiative categorizations from the literature.
- The effect of EE and ecological responsibility on SC efficiency is examined.
- In EE and environmentally friendly SCs, consumer engagement is vital to improving the SC.
- It analyzes relevant Information Communication Technology (ICT) to promote EE and sustainable development in SCs.

Research Themes

The different themes for supply chain management with energy efficiency are discussed in this section.

Supply Chain Management

SCM has garnered academic and practical interest for over 20 years. It is the layout, management, and execution of a mechanism to optimize the generation of value across the lifespan of a good with adaptive recovery of value from diverse kinds and quantities of turnovers. Remanufacturing and recycling would occur throughout product lifespans in SCs to optimize EE. SCM constitutes a component of circular SCM and is aligned with the circular economy.

SCM demands logistical architecture. Developing SC systems is a vital strategic choice that has garnered academic interest. Previous studies have shown "generic" designs of networks for SCs and network architecture for particular product categories like airplanes, cars, and major home appliances with variable quality. Reverse movement of goods in systems increases SC decision uncertainty at all levels. Many scholars have tried to predict SC risks.

Strategic choices like SC network architecture need SC drivers to recognize and combine operational and operational decisions to save cost or increase value. The research has examined incorporated decision-making in future capacity planning, supply restocking, resource scheduling, product structure, and flexibility, designing choices (essential versus flexible layout) and their effects on purchasing and vendor rivalry, and breakdown balance of lines.

SC activities concentrate on returns or recoveries. Over the good's life cycle, advertisement, restoration, guarantee, end-of-use, and end-of-life return can happen. Used for inventory supervisors, reused product disposal, remanufacturing, and marketing are product recovery operations. The research generally examines two methods for collecting old items from consumers. These might include producer-direct collecting and merchant or third-party collecting. Optimised Energy Management (OEM) encourages recycled goods in decentralized channel systems by incentivizing merchants [5]. Companies subcontract end-of-use purchasing to merchants if they have similar ecological and operational outcomes for simplicity and to optimize EE. The main aspects of SCM are shown in Fig. 2.

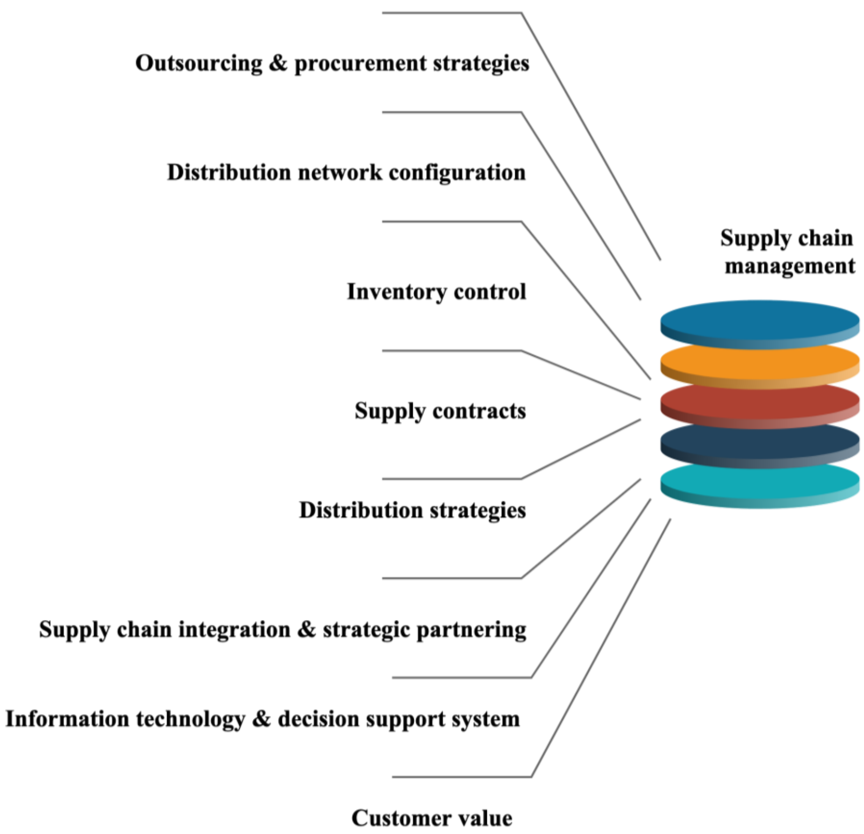

Fig. 2. Main aspects of SCM

Due to the high salvaging value of end-of-use items, SC reversed pathways are becoming more competitive. Due to cost and promotional considerations, producers seldom remanufacture. This allows third-party remanufacturers to compete with new goods. Technology leasing by companies helps them compete with third parties. Effective contractual method coordination also optimizes SC recovery effectiveness and EE with competing groups. Studies indicate an uncommon SC structure that matches the Dell Reconnect initiative, where the company sells new items, and a goodwill organization collects and sells old devices [6]. The research suggests that producers should constantly contain, via a goodwill organization, high goods resale potential options.

Reverse SCM

Reverse SCM is the optimal administration of the operations needed to reclaim an item from a client and dispose of or reclaim value [7]. Commercial earnings, guarantee replacements, leasing equipment extensions, and reused item returns drive reversing operations and flows. Changing flows from consumers to factory facilities include gathering, assessment, organizing, removal, reprocessing, and dumping.

Several research examines reversed channel network architecture. Industry-specific instances include building a paper recovery system, end-of-lease computer equipment, and a silicon company's guarantee delivery system. Changing SCM choices are unknown. Above all, recovered merchandise quality is generally unpredictable, which impacts product recovery revenue. Like SCM, retailer-managed groups are a favored reversed channel due to cost savings and recovery of goods rates. More customer returns complicate managing inventories, scheduling production, and transportation of vehicles to optimize EE. In consumer electronics, unwanted returns account for 50% of all returns. The study recommends educational initiatives that teach consumers how to utilize the device. Research suggests shared revenue agreements among reversed SC actors and trade-in price structures.

Legislation and Policies

Limited resources and warming temperatures have prompted governments worldwide to implement regulations, strategies, and initiatives to promote sustainability in society and the environment [8]. The latest and largest package is the European Union (EU) Sustainable Development Instructions, which promotes substance circularity via reusing and refurbishing and emphasizes the reuse of goods to recover materials. Take-back rules oblige companies to pay for the collection and destruction of goods. Free take-back systems are required under the EU Regulation. The Directive requires OEMs to gather, recuperate, and dispose of end-of-life goods. Many nations have established Extended Producers Responsibility (EPR) regulations regarding take-back laws. An ecological strategy concept called EPR extends the duty of care for good to its post-consumer lifetime cycle.

Remanufacturing and selling reconditioned items boosts sales and profitability for producers. Successful take-back initiatives at the business and supplier chain levels require tactical and operational recovery of product plan choices. A manufacturer's strategy manufacturing choices must incorporate life-cycle factors and revenue. Product eco-design and installation base management—product leasing with maintenance and maintenance—are examples. The operating level choice requires considering the good and element breakdown and restoration operations. Effective agreements between producers and customers help at each manufacturing level. Shared recovery of goods responsibilities boosts SC EE efficiency.

In reaction to take-back laws, buyback, and trade-in schemes have been created to collect old consumer items for product and material recycling. The repurchase and trade-in policies give cash for returns and discounts for consumers replacing old items with fresh ones. The repurchase and trade-in schemes help refurbishment. Products could be marketed second-hand. The cannibalization impact among new and refurbished items must be addressed by analyzing optimum price, second-hand buyers' most outstanding readiness to pay, and manufacturing cost.

Emissions-trade policies employ governments and market controls to limit greenhouse gas pollutants. Facilities protected by the scheme are limited in their greenhouse gas emissions. Businesses obtain or purchase emission permits within the quota and exchange them as required.

Under strict EE restrictions, enterprises must manage greenhouse gas pollutants. Refurbishing is essential to reduce production-related carbon pollutants in the research. The limit-and-trade law will decide the producer's utilized item collecting choice for refurbishing on the party's average carbon emissions, not the company's profitability. The paper presents models to reduce transportation costs by including carbon pollutants in the SC with limit-and-trade. Finally, subsidy programs financially incentivize manufacturers to refurbish or encourage consumers to purchase them. The Chinese authorities subsidized household equipment improvements.

Remanufacturing SCM

Remanufacturing recovered items to function like new is a more significant recovery. In recent decades, scholars and practitioners have focused on refurbishment [9]. SCs and autonomous third-party (3P) refurbishing are the

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main methods. A producer (typically an OEM) remanufactures itself or outsources to a third party in SCs. When OEMs lack the incentive or capacity to refurbish end-of-use items, a third-party remanufacturer capitalizes on the opportunity. Some OEMs charge exorbitant prices for exclusive spare components or build un remanufactured goods to prevent 3P remanufacturers.

Remanufacturing is lucrative but requires thoughtful planning. First, refurbishing should constantly benefit the combined producer if its price is low enough to avoid cannibalization. Secondly, centralizing producing and refurbishing activities affects design and revenue. They are third, redoing an unsuccessful venture for non-integrated companies or suppliers of parts, lowering their earnings. The possible cannibalization impact of refurbished items on new goods sales and uncertainty regarding rejected product quantity and caliber continue to dissuade OEMs from developing in-house refurbishing capabilities. Various forecasting methodologies have been designed to help organizations construct more accurate refurbishing projection models. The research focused on practice addresses like seeding—selling fresh goods as repaired at the start of their lifecycle—have been shown to boost core recuperation amounts, enable efficient refurbishing before, and improve OEMs' capacity to meet requests for refurbished items throughout the lifespan.

SC Collaboration

The research extensively encourages SC collaboration for material sustainability [10]. Cooperation boosts reversed SC efficiency and efficiency. Companies increasingly realize the necessity to synchronize production and refurbishment. Adequate SC cooperation benefits all participants. OEMs and unaffiliated remanufacturers cooperate on licensing technologies and research and development joint ventures, while producers and transportation companies cooperate on recycling trash and sharing resources. Whenever SC participants have conflicting goals, they compete for recovery efforts and aftermarket revenues. The study recommends joint maximizing to align firm incentives to complete material chains for triple bottom lines.

Technologies and Information

Details value enhances SC efficiency when returns of goods and reuse produce ambiguity about the request, product exchange, recovery, and facility utilization. Study shows that SCs with advanced product returning notice decrease inventory variation, eliminate the lead time dilemma, and optimize variable SC efficiency. The study analyzes production and vendor remanufacturing across four information-sharing situations, from no to complete. They discover that knowledge sharing helps suppliers and manufacturers but hurts retailers owing to double marginalization.

A Decision Support System (DSS) helps organizations make choices, conclusions, and actions. Effective DSS adoption has increased reversed SC efficiency and profitability. The circular structure for SC resource viability and decision-support technique for measuring resource viability versus its basic premises. Online marketplaces have made buying and selling easier in recent years. This encourages reuse and reduces composting and other dumping methods.

Recycling SCM

They are recycling the oldest value-recovering method [11]. Paper, plastic, metallic substances, and glass from municipal solid trash are best recycled for ecological and economic reasons. Current value recovery methods involve reusing returned materials more than reconditioning and refurbishing. It is recommended for strategic supplies. While it is typically seen as harmful to the official waste recovery structure, Salvaging benefits financial, ecological, and social stability if authorized. According to recovery channel rivalry and processing of waste efficiency, waste disposal selects e-Stewards or Responsible Recovery accreditation.

Industrial Symbiosis

The industrial partnership reuses, recycles, and reprocesses contaminants and intermediaries throughout the ecosystem of enterprises in and beyond the initial SC, unlike traditional SCs [12]. The symbiosis between industries can improve SC integrity and reuse, but research ignores it.

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Conclusion and Findings

SCM serves various stakeholders; EE has recently become a vital strategic resource for economic and social growth. EE saves business customers money and increases competitiveness, revenue, excellence, and working conditions. Even with these advantages, most companies need help and often even fight to execute EE measures. Lack of finance and knowledge are the biggest challenges for SMEs. SCM is one technique to overcome such hurdles and help low-competitive enterprises adopt energy-saving initiatives. Since most current research has concentrated on the single firm perspective, this work attempts to offer a systematic assessment of peer-reviewed journal articles on EE incorporated into SCM and characterize an investigation stream to develop this topic further. Only some studies in this research have incorporated EE considerations into SCM utilizing subjective and quantitative methods.

Qualitative articles have mainly shown how energy-related problems affect the efficiency of the SC, the optimum decision-making procedure, and the chance to enhance EE through SC collaboration. Most of the examined research's quantitative frameworks try to include energy flow expenses in all SC expenses. Few have included EE as a neutral parameter or decision-making variable. The results suggest that SC architecture and administration EE should be studied more. Practical and research possibilities abound for this area. Recently released publications do not investigate particular SC EE strategies. Contrasting and evaluating available solutions in different industries would be fascinating as they have varying significance and implications.

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