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Managing Inventory Risks in SMEs: Strategic Approaches to Stocking, Supplier Choice and Digital Solutions

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ABSTRACT

In a globalized and unpredictable economic environment, effective and strategic inventory management plays a key role in the life of every business. This is especially true for small and medium-sized enterprises (SMEs), which are forced to respond quickly and flexibly to changing market demands with limited resources. This study examines the strategic importance of inventory management using the example of a Hungarian SME, qsd2 Kft., with a particular focus on geotextiles as a key product category. The research focuses on two key questions: the impact of the introduction of the consignment inventory model on the financial stability and customer service of , and the role of the geographical diversification of the supplier network (domestic, EU, and Chinese partners) in terms of cost efficiency and risk management. The study, which combines qualitative and quantitative methods—based on an analysis of company documents, semi-structured interviews, and procurement data—shows that consignment stocking has significantly improved the company's liquidity and reduced customer dissatisfaction due to stock shortages. In addition, the conscious geographical diversification of suppliers contributed to increased security of supply and reduced cost volatility. At the same time, the practical application of the model has also brought administrative, legal, and communication challenges to the surface. One of the most important lessons of the research is that inventory management can become a real competitive advantage for SMEs if it is supported not only at the operational level but also with a strategic and technological approach. Digital decision support systems, advanced demand forecasting techniques, and the integration of sustainability considerations can open up new perspectives in inventory optimization. Future research could expand our knowledge of this topic through cross-

sector comparisons and a deeper examination of the role of IoT-based inventory monitoring and AI-supported forecasting solutions.

Keywords: Inventory Management; Consignment Model; Small and Medium-Sized Enterprises (SMEs); Supplier Diversification; Digital Decision Support

INTRODUCTION

Globalized markets, digitalization, and rapidly changing customer expectations are presenting new challenges for companies at all levels of the supply chain. In this unpredictable and often turbulent economic environment, it is particularly important for organizations to manage their inventory efficiently and strategically. Inventory management is not just an operational function within logistics and production control, but a complex corporate activity that has a direct impact on cost efficiency, liquidity, customer satisfaction, and competitiveness. Inadequate inventory levels, whether too high or too low, can directly threaten the sustainability of a company's operations. Classic inventory management models—such as economic order quantity (EOQ), safety stock, and ABC analysis—have provided a solid basis for decision-making for decades, especially among large companies. In recent years, however, technological innovation, the globalization of supply chains, and digitalization trends have brought new, modern tools and methods to inventory management. These include predictive analytics, automated inventory monitoring, real-time data-driven decision-making, and the adaptation of lean and just-in-time (JIT) principles in various industries. At the same time, the strategic importance of inventory management has also increased, as it is increasingly linked to supply chain flexibility, procurement and sales strategies, and increasing corporate resilience. The issue of inventory management is particularly important for small and medium-sized enterprises (SMEs), which often operate with limited financial, technological, and human resource capacities. While large companies have access to advanced ERP systems, integrated logistics platforms, and predictive models, SMEs often use simpler, intuition-based inventory management practices that are not always able to keep up with rapid changes in demand or supplier conditions. At the same time, the agility and direct market connections of the SME sector provide an opportunity to quickly adapt to a modern approach to inventory management, especially when supported by information systems, digitalization, and organizational knowledge development. When optimizing inventory, companies must constantly balance inventory carrying costs, service levels, and demand risks. Overstocking ties up capital and poses a risk of obsolescence, while understocking can lead to lost market opportunities or customer dissatisfaction. This classic dilemma has taken on new dimensions today: geopolitical instability, supply chain vulnerability, and sustainability and ESG (Environmental, Social, Governance) considerations are all contributing to the transformation of inventory strategies. Green logistics, circular economy principles, and ethical procurement are increasingly influencing inventory management decisions. The following section presents the basic concepts and classic models of inventory management, followed by an exploration of modern approaches and technological innovations that open up new opportunities, especially for small and medium-sized enterprises. The aim of the study is to explore how these companies can combine traditional and modern tools to develop inventory management strategies that respond to market challenges and serve long-term sustainable operations.

LITERATURE REVIEW

Theoretical Foundations and Approaches to Inventory Management

Inventory management is a key element of a company's logistics and operational system, and its effective operation has a direct impact on competitiveness, cost control, and customer satisfaction (Demeter, 2016; Gritsch, 2003). The primary role of inventories—which can be raw materials, semi-finished products, finished products, or auxiliary materials—is to ensure continuous production and sales while reducing the risks associated with stock shortages and excessive capital tied up (Silver et al., 1998; Munyaka & Yadavalli, 2022).

The fundamental goal of inventory management is to minimize inventory holding and ordering costs by establishing optimal inventory levels, while at the same time being able to meet changing demand and ensure the smooth operation of the supply chain (Heizer et al., 2020). Among the classic models, the EOQ (Economic Order Quantity) model stands out, which serves to optimize order quantities, taking into account the balance between ordering and inventory costs (Dobos, 2009). ABC analysis allows stocks to be categorized based on value and consumption frequency, which helps to differentiate the management of resources (Chopra & Meindl, 2019; Christopher, 2016; Kozma et al., 2025). The importance of safety stock is particularly appreciated in times of

uncertain demand and delivery times, as it ensures that service levels are maintained – a challenge that particularly affects small and medium-sized enterprises (SMEs), which often have lower inventory turnover rates and limited capital (Slack et al., 2022; Ghobakhloo & Tang, 2013). Modern inventory management approaches include lean management and the Just-In-Time (JIT) system, which aim to minimize inventory by eliminating waste and maximizing flow value (Womack & Jones, 2003; Ohno, 1988). These methods can be particularly effective in environments where demand is stable and supplier reliability is high. However, they can be challenging for SMEs operating in unpredictable markets, where flexibility is often more important than minimizing inventory levels (Demeter, 2016).

Demand forecasting is becoming increasingly important in inventory strategy planning, as it allows for more accurate demand estimation and inventory level optimization. In addition to traditional statistical methods, machine learning and artificial intelligence-supported solutions have also emerged, making inventory management more adaptive to volatile environments (Albarune & Habib, 2023; Sharma, 2024). Parallel to the spread of digitalization, inventory management is also becoming increasingly real-time and data-driven. Advanced ERP systems, IoT devices, and predictive analytics enable dynamic monitoring of inventory levels and facilitate automated decision-making (Gubán & Udvaros, 2022; Szabó-Szentgróti et al., 2025). Supply chain integration, real-time information sharing, and flexible logistics capacity play a key role in increasing the robustness and adaptability of the supply chain (Guo & Liu, 2024).

Theoretical Possibilities of Inventory Optimization

Inventory optimization is one of the most important elements of modern logistics and supply chain management, with the aim of managing inventory levels in such a way that the company minimizes costs and maintains operational continuity at the same time (Olson & Swenseth, 2014; Shukla & Agarwal, 2011). Finding the optimal inventory level depends on several factors: the accuracy of demand forecasting, the development of delivery times and costs, storage conditions, and the complexity of the supply chain. The right inventory strategy is therefore not just an operational decision, but also a strategic issue that directly affects the competitiveness and financial performance of the company.

Optimization Goals and Indicators

The theoretical basis for inventory optimization is the alignment between performance indicators and optimization objectives. It is essential for companies to develop measurement systems that can evaluate not only cost efficiency, but also service levels and flexibility. According to Melnyk, Stewart, and Swink (2004), performance measurement plays a critical role in managing organizational operations, but poorly structured indicator systems can result in a "labyrinth of metrics" that hinders effective decision-making. To overcome this, Malloch (1999) developed the performance indicator matrix model, which provides a transparent, hierarchical framework for prioritizing optimization goals. The model helps to ensure that indicators are closely linked to corporate strategy, thereby improving resource allocation and decision transparency (Berde et al., 2025). The use of inventory management indicators is also crucial in supply chain management. Ren (2006) showed that (t,R) inventory control rules can be used to optimize inventory replenishment, reduce shortage costs, and increase customer satisfaction. Qi and Shen (2022) pointed out that incorporating predictive models into the performance measurement system enables faster and more informed decision-making, especially in volatile market environments. Gunasekaran (2015) emphasizes that appropriate performance indicators are also essential for optimizing outsourcing decisions, as they enable objective comparisons between different alternatives, supporting cost reduction and flexibility enhancement goals. Continuous review of indicator systems is essential, as the rapidly changing market and technological environment requires regular recalibration of data and targets. Digital transformation and data-driven decision-making enable the fine-tuning of indicators, allowing companies to respond dynamically to environmental changes (Qi & Shen, 2022).

Risks, Cost Factors, and Trade-offs

The essence of inventory optimization is to strike a balance between conflicting goals. Low inventory levels reduce storage costs and capital tied up, but increase the risk of supply disruptions and customer dissatisfaction. Higher inventory levels, on the other hand, increase security and flexibility, but come with additional costs (Olson & Swenseth, 2014). In order to consciously manage the trade-off between efficiency and flexibility, Shukla and Agarwal (2011) propose robust inventory models that help reduce uncertainty by modeling disruption costs. In recent years, sustainability has also become one of the optimization goals. According to Darvish (2019), optimal inventory management serves not only economic but also environmental goals: for example, by shortening

transport routes, reducing energy consumption, and prioritizing local sourcing. Multi-objective optimization methods enable companies to simultaneously consider costs, service levels, and sustainability, thereby developing more complex and balanced decision-making systems (Santos, 2024).

The Role of Decision Support Tools

For modern companies, inventory optimization cannot be achieved effectively without advanced decision support systems. Decision Support Systems (DSS) are integrated solutions that analyze inventory levels based on real-time data, forecast demand, and make recommendations to decision makers (Beheshti, 2010). DSSs are particularly valuable for small and medium-sized enterprises, as they facilitate adaptive inventory management and rapid response to market changes (Teerasoponpong & Sopadang, 2022). The example of GlaxoSmithKline illustrates the practical benefits of DSS: the company significantly reduced inventory costs and improved product availability with its proprietary system (Shang et al., 2008; Balassa et al., 2024). The integration of artificial intelligence and machine learning has opened up a new dimension in inventory optimization. Modern, intelligent DSSs are capable of identifying patterns, managing uncertainty, and making proactive recommendations (Long et al., 2023). Exponential smoothing remains an effective method for short-term forecasting, especially in the retail sector (Sihotang, 2023). In healthcare, DSSs use predictive algorithms to optimize drug inventories, minimizing the risk of shortages and overstocking (Fernandez et al., 2020).
Alternative solutions include object-oriented systems, which offer a modular and flexible approach (Chen & Sinha, 1996) and framework-based decision support systems, which support decisions at both the strategic and operational levels (Cadavid & Zuluaga, 2011). In the future, further integration of big data and artificial intelligence is expected, enabling proactive, predictive inventory management, thereby increasing the adaptability and sustainability of companies.

Characteristics of Small and Medium-Sized Enterprises

Small and medium-sized enterprises (SMEs) are key players in national economies, contributing significantly to employment, innovation, and economic diversification (Algan, 2019; Robu, 2013). Their flexible organization, rapid adaptability, and local market knowledge make them particularly valuable in unstable economic environments. At the same time, their vulnerability—due to limited financial, technological, and human resources—justifies the priority treatment of effective inventory management. SMEs play a decisive role in both developed and developing economies. Supporting these businesses is also a key objective of the European Union's economic policy, as they contribute to reducing regional disparities, developing the knowledge-based economy, and renewing industrial structures (Keskin et al., 2010; Savlovschi & Robu, 2011; Dajnoki et al., 2023). Their rapid response to market changes and active participation in exports contribute to strengthening international competitiveness. From a social perspective, their close ties with local communities promote social cohesion and greater economic participation (Robu, 2013). For all these reasons, supporting SMEs is justified not only from an economic stimulus perspective, but also from a social policy perspective. SMEs face a number of obstacles in the area of inventory management. Inaccurate demand forecasting, a lack of data-driven decision support, and limited analytical capabilities often lead to excess or shortage of inventory (Kittisak, 2023). Outdated technology, lack of automation, and inaccurate record-keeping systems reduce operational efficiency and reliability (Panigrahi & Shrivastava, 2024). Deficiencies in logistics infrastructure, such as inadequate storage conditions or low storage capacity, further hamper effective inventory management (Chan, 2017; Horváth et al., 2025). The COVID-19 pandemic has clearly highlighted the benefits of lean, flexible inventory management: such businesses had a competitive advantage during the crisis as they were able to respond more quickly to logistical disruptions (Lefebvre, 2024). Excessively high inventory levels can tie up unnecessary capital, while excessively low levels can lead to customer dissatisfaction. Achieving the optimal balance requires continuous review of inventory policy (Alam, 2024). Barriers to the development of SMEs include outdated technological infrastructure, a lack of digital skills, and slow adaptation, which hinder innovation and market responsiveness (Dhondt, 2018; Cressey & Di Martino, 2013). In addition, due to limited financial resources, many businesses postpone or abandon the introduction of new technologies, which reduces their competitiveness (Gomez & Vargas, 2009; Hoegl, 2008; Hewitt-Dundas, 2006; Keller & Gombos, 2025). The lack of human resources, especially the availability and retention of skilled labor, is a major obstacle to the introduction of new technologies and the exploitation of innovation capabilities. Technological development is faster than the adaptation of education systems, which can lead to a skills gap (Lee & Jung, 2024; Peng, 2020; Dartey-Baah, 2010; Kőmíves et al., 2024).

The Impact of the External Environment on Inventory Management

Inventory management is not an isolated corporate activity, but is increasingly influenced by the global economic and political environment. In addition to traditional cost and efficiency considerations, companies now have to take into account international trade relations, political instability, and the security of transport routes. The economic relationship between China and the European Union and the impact of geopolitical tensions on the reliability and adaptability of supply chains are particularly significant.

The Evolution of EU-China Trade Relations

Over the past two decades, a closely integrated economic partnership has developed between the European Union and China, which is not only of commercial but also of strategic importance (Leal-Arcas, 2010). The EU is one of the largest markets for Chinese products, while China is a vital supplier to European industry, particularly in the electronics, engineering, pharmaceuticals, and consumer goods sectors. However, despite economic integration, tensions have also arisen between the two sides, mainly around market access, intellectual property rights protection, and the asymmetry of state subsidies (Dadush, 2019). The EU is increasingly recognizing the vulnerabilities of its economic dependence, particularly in the areas of critical raw materials, components, and technological products. As a result, it is seeking to reduce its exposure in line with the principle of "strategic autonomy," while continuing to maintain its trade relations with China (Goulard, 2020).This new approach incorporates political and value-based considerations into economic decision-making, for example in the areas of human rights, environmental sustainability, and global governance (Christiansen & Maher, 2017; Berde et al., 2025). All of these are reflected in corporate strategies, for example in the diversification of procurement sources or more conscious planning of inventories.

Geopolitical Risks and Transport Routes

Globalized supply chains are increasingly disrupted by geopolitical events. Sanctions, regional conflicts, blockages of maritime transport routes, and congestion at supply points all pose significant risks to inventory management. In this context, the Chinese Belt and Road Initiative (BRI) aims to establish alternative trade routes that directly connect China with Europe (Naumov, 2024; Malatyinszki et al., 2025). Chinese port investments, such as in Piraeus, Greece, have reinforced the dominance of maritime logistics, but have also highlighted its sensitivity to political tensions (Alvstam, 2020). In response to these challenges, alternative transport corridors, especially rail routes, are receiving increasing attention. The Trans-Caspian corridor, for example, offers a faster and more predictable transport solution, reducing the risks associated with maritime bottlenecks such as the Strait of Malacca (Liu & Fu, 2024).. Rail logistics is not only advantageous from a geopolitical perspective, but is also preferable from an environmental point of view, contributing to the development of sustainable supply chains (Rentschler et al., 2025). The EU's long-term logistics strategy is based on the diversification of transport routes and sources of supply, which is not only beneficial from a corporate risk management perspective, but also increases security of supply at the macroeconomic level (van der Linden & Łasak, 2024). For companies, this means rethinking their inventory management policies: the role of safety stocks is increasing, the need for flexible transport capacity is emerging, and predictive models for managing demand fluctuations are coming to the fore (Demircan, 2024).

The Impact of Inventory Management on Corporate Performance

Maintaining optimal inventory levels and composition directly affects a company's operational efficiency, financial stability, and market position. Excessive stockpiling results in capital tie-up, storage costs, and impairment, while understocking can lead to stock shortages, delays, and customer dissatisfaction (Chopra & Meindl, 2019). Optimal inventory management is therefore of strategic importance as it contributes to achieving a balance between cost efficiency, flexibility, and competitiveness.

Cost Efficiency, Competitiveness, and Customer Satisfaction

The three key factors of corporate success—cost efficiency, competitiveness, and customer satisfaction—are closely interrelated. Enaworu (2018) and Kálmán et al. (2021) point out that cost-effective operation does not only mean reducing expenses, but also promotes improved service quality and customer satisfaction. The integrated management of operational efficiency and human factors thus forms the basis for long-term competitive advantage.

Suchánek, Richter, and Pokorná (2014) demonstrated in their empirical research conducted in the food industry that product quality, cost control, and customer satisfaction are mutually reinforcing elements: companies striving for quality and reliability are able to maintain their competitiveness even in the face of intense price competition (Kozma et al., 2025). According to research by Anderson, Fornell, and Rust (1997), increasing customer satisfaction may result in higher costs in the short term, but in the longer term it increases productivity and profitability.
The efficiency of logistics processes and the supply chain also fundamentally determines corporate performance. Burity (2021) points out that a well-organized and digitized supply chain can simultaneously reduce costs and improve service levels. Shah and Regassa (2010) came to a similar conclusion when they examined Japanese quality management practices and found that continuous improvement and quality investments not only reduce costs but also provide a lasting competitive advantage. Overall, it can be said that a dynamic balance between cost efficiency, competitiveness, and customer satisfaction is a fundamental prerequisite for corporate success. Inventory management plays a key role in linking these factors: optimal inventory levels ensure rapid response, service quality, and cost control.

The Relationship between Inventory Management and Strategic Decisions

Inventory management is no longer merely an operational function, but a strategic decision-making area that directly affects a company's liquidity, financial performance, and competitiveness. When developing inventory policies, managers must weigh the trade-offs between costs, risks, and customer satisfaction (Chopra & Meindl, 2019). One of the main advantages of the Just-in-Time (JIT) system is the minimization of inventory levels and storage costs, but it increases supplier risks and requires a high degree of coordination (Heizer et al., 2020). Modern companies therefore often use hybrid approaches that combine the efficiency of JIT with the flexibility of safety stocking. Technological advances have opened up new dimensions in strategic inventory management. Decision support systems based on artificial intelligence, predictive analytics, and big data analysis enable more accurate demand forecasting, inventory level optimization, and proactive risk management (Christopher, 2016). Data-driven models enable companies to synchronize procurement, manufacturing, and distribution processes, reducing excess inventory without compromising service levels. This approach offers not only efficiency but also strategic advantages: companies can respond more quickly to market changes, increase their adaptability, and strengthen their long-term competitiveness. Strategic inventory management is therefore a key element of sustainable growth, integrating financial, logistical, and customer value considerations.

Sustainability and Digitalization

The integration of sustainability and digitalization is one of the most important trends in modern inventory management. Through digitalization, companies are able to optimize resource utilization, reduce material waste, and minimize environmental impact. Automated systems, predictive maintenance, and big data analytics contribute to the simultaneous improvement of environmental and economic sustainability (Chen, 2020). The circular economy and the use of digital sharing models create new business opportunities while reducing material consumption and waste generation (Rosário & Dias, 2022). At the same time, the sustainability paradox of digitalization also emerges: the operation of technological systems and the production of devices involve significant energy consumption and electronic waste (Seele & Lock, 2017; Balassa et al., 2024). In the case of small and medium-sized enterprises (SMEs), the role of corporate culture is particularly important in the successful integration of sustainability and digitalization. According to Isensee (2020), a culture that represents sustainability values promotes innovation and responsible technological adaptation. The European Union's Digital Agenda (Kamolov & Stepnov, 2020) also highlights that digitalization is one of the main drivers of sustainable economic growth, encouraging member states to introduce environmentally friendly innovations. Overall, the convergence of digitalization and sustainability is setting a new direction for inventory management: data-driven, responsible, and flexible operations contribute not only to competitiveness but also to strengthening social and environmental responsibility.

METHODOLOGY

The aim of this study is to provide a comprehensive and systematic overview of the strategic importance of inventory management using the example of a small and medium-sized enterprise based in Hungary, *qsd2 Kft.* The company specializes in the distribution of safety solutions for green roof and flat roof systems, and one of the key elements of its product portfolio is geotextiles. The procurement, storage, and use of this product range poses complex logistical and financial challenges, especially in light of the fragility of global supply chains and macroeconomic uncertainties. The research focuses on the company's inventory management decision-making

practices, with particular attention to the use of the consignment inventory model and the geographical and structural diversification of the supplier network. The aim of the study is to explore the specific operational solutions used by the company to mitigate inventory risks, such as exchange rate fluctuations, long delivery times, inventory holding costs, and supplier reliability. The methodological framework is based on a case study approach that integrates qualitative and quantitative elements. Data collection was based on several sources: inventory and financial data from *qsd2 Kft.'s* internal accounting systems, documents related to procurement and logistics decisions, and informal, semi-structured consultations with company experts. This multi-source approach enabled an in-depth understanding and contextual interpretation of the practices examined. In the first phase of the research, I examined the supplier sources used by the company—including domestic, European Union, and Chinese partners—from the perspective of geotextile procurement. When comparing the various alternatives, I took into account the factory price, transport costs, customs duties, delivery time, payment terms, and quality assurance aspects. I presented the various parameters in tabular form and calculated the total unit costs and total procurement values for each procurement option, enabling an objective comparison of cost-effectiveness.

One of the key elements of the practical study was the analysis of the use of consignment stocking. I explored in detail the company-specific characteristics, advantages, and limitations of the model, with a particular focus on its financial impact and its role in optimizing inventory value. During the analysis, I evaluated the impact of the consignment model on liquidity management, inventory turnover indicators, and maintaining procurement flexibility. During the quantitative analysis, I calculated inventory turnover and liquidity indicators based on internal company reports. The analysis of corporate practice was supplemented by an examination of the market environment. By analyzing current statistical data and trends in the global and domestic markets for geotextiles, I highlighted the external economic and supply chain factors that influence the company's inventory management strategies. Particular attention was paid to longer delivery times, raw material shortages, inflationary effects, and geopolitical and logistical risks.

In line with the objectives of the research, based on a case study analysis of qsd2 Kft.'s inventory management practices, we formulated the following research questions, which examine the effects of the consignment model used by the company and the geographical diversification of its supplier network:

- RQ1: How does the use of the consignment inventory model affect the company's financial stability, liquidity, and customer service flexibility, using the example of a small and medium-sized enterprise?
- RQ2: How does the geographical diversification of the supplier network (domestic, EU, and Chinese partners) affect procurement costs, delivery flexibility, and inventory management risk?

The practical analysis focuses on qsd2 Kft., based in Győr, which was founded in 2020 and currently employs 21 people. The company's main activity is the design, manufacture, and wholesale of architectural products, classified under TEÁOR 4690 (Other mixed product wholesale). Operations are conducted in accordance with the ISO 9001:2015 standard and domestic occupational safety regulations, including Act XCIII of 1993 and the MSZ EN 795 standard. qsd2 Kft. primarily offers safety products and design services related to green roofs and flat roofs. These roof surfaces are playing an increasingly important role in sustainable urban development practices, as they contribute to mitigating the urban heat island effect, improve air quality, increase the thermal insulation performance of buildings, and reduce stormwater drainage loads. They also provide habitats for various plant and animal species, thereby increasing urban biodiversity. The global market for green roofs is growing rapidly: in 2024, its value reached USD 14.3 billion, and it is expected to grow to USD 41.6 billion by 2033, with an annual growth rate of 12.6% (Global Growth Insights, n.d.). Europe, the market leader, accounted for 72.6% of the global share in 2024, mainly due to environmental regulations and the EU Green Deal (Grand View Research, n.d.). Extensive green roofs dominate the segment (84.8%) due to their low weight and maintenance requirements (Grand View Research, n.d.). Commercial buildings account for the largest share of use (63.7%), but the residential sector is also growing dynamically, with an annual growth rate of 16.3% (Grand View Research, n.d.). Flat roof systems also pose specific safety challenges, for example during regular maintenance (e.g., irrigation system management, roof structure repairs). Accordingly, fall protection and accident prevention are of paramount importance. qsd2 Kft.'s product range and services provide professional solutions to these challenges, in line with quality expectations and standards. The company's goal is to maintain high-quality design, product manufacturing, and wholesale sales, while striving to ensure long-term market competitiveness and financial stability. International market integration has been a strategic step forward, giving qsd2 Kft. access to a stable, predictable customer base, significantly increasing its sales potential. This business position can not only result in increased turnover, but also contribute to the company's economic stability and sustainable growth.

RESULTS AND DISCUSSION

Geotextiles are versatile synthetic materials that perform a number of basic functions in geotechnical systems: they separate soil layers, filter suspended particles in water, drain moisture, increase soil stability, provide protection against mechanical damage, and reduce erosion. Based on these properties, in addition to transport infrastructure (e.g., roads, railways), water management facilities (e.g., canals, dams), and environmental protection investments (e.g., landfills), they are also becoming increasingly important in the development of urban green spaces, including green roofs. In the case of green roofs, geotextiles act as layer separators, drainage and erosion protection, contributing to the long-term stability and functioning of the system. They are also widely used in horticultural and agricultural applications, where they act as root barriers, reduce soil erosion and regulate moisture. Based on global and European market data, demand for geotextiles is growing steadily, driven by infrastructure developments, sustainability efforts, and innovative material technologies.

- The global market was valued at USD 7.91 billion in 2024 and is expected to grow to USD 15.02 billion by 2034, at a compound annual growth rate of 6.7% (Polaris Market Research, 2024).
- The European market was valued at USD 598 million in 2023 and is estimated to reach USD 1.1 billion by 2029 (TechSci Research, 2024).
- In Germany, the market volume of geotextiles will be USD 251.8 million in 2024, which may increase to USD 346.7 million by 2030 (Grand View Research, 2024).

Specific Features of Geotextile Inventory Management

The stocking of geotextiles is a technically and logistically complex task, as the products vary in type (woven, non-woven), size, and physical characteristics. Storing them in rolls requires a lot of space and special attention must be paid to protecting them from environmental influences. The standard roll size of 2 m x 100 m is commonly used in green roof applications, as it is optimally suited to construction practices. QSD2 Kft. also aligns its inventory strategy with these dimensions. Due to project-based operations and seasonal demand fluctuations, accurate inventory planning, determination of safety stocks, and coordination of procurement cycles are key. The company works with domestic, EU, and Chinese suppliers, but their logistics and administrative practices differ. While domestic partners provide fast and flexible service, Far Eastern sources offer lower unit prices but longer delivery times (Table 1). Experience shows that relying on a single source of supply (e.g., exclusively Chinese imports) carries significant risk. Diversifying the partner network—taking into account both cost and time efficiency—is strategically important for maintaining the company's liquidity, market position, and customer satisfaction.

Table 1. Logistics and administrative processes

Procurement method	Delivery times	Order processing
From Hungary	Within 1–2 working days after production	Flexible, smaller quantities can also be manufactured
Within the EU (from abroad)	Within 2–4 business days after production	Moderately flexible, surcharges may apply for smaller quantities
From China	18–45 days after production (by sea: 30–45 days, by rail: approx. 18–20 days)	Inflexible, only large quantities (full container)

Source: own compilation based on the database of qsd2 Kft.

Supplier relationships and alternative sourcing options

Due to the volatility of the global economic environment and regular disruptions affecting supply chains, it is becoming increasingly important for qsd2 Kft. to rethink and diversify its supplier relationships. The traditional model of relying on a single main supplier is now considered less and less sustainable, as it represents increased exposure from an economic, financial, and logistical point of view. The company's growing turnover and customer expectations require the development of a more flexible and secure supply structure. As part of this process, qsd2 Kft. has begun to explore and integrate alternative supplier options. In expanding its supplier portfolio, the company is examining three main sources: Hungarian, European Union, and Far Eastern (primarily Chinese) manufacturers. The differences between the procurement channels are not only in terms of price, but also in terms of payment terms, customs costs, and delivery times, so decisions can only be made on the basis of a complex cost and logistics analysis (Table 2).

Table 2. Comparison of procurement sources (from a logistical and financial perspective)

Procurement method	Payment terms	Purchase price	Customs costs	Shipping costs
From Hungary	30 days on average	High, citing energy prices	None	approx. 100,000 HUF
Within the EU (from abroad)	30 days, but 14 days is common 3% discount	High, citing energy prices	None	approx. EUR 1,000 (= approx. HUF 410,000)
From China	Advance transfer	Low, up to 50–60% cheaper	3.6	Sea: USD 5,000; Rail: USD 10,000

Source: own compilation based on the database of qsd2 Kft.

The total costs associated with the various sources clearly illustrate the price advantage of purchasing from China. At the same time, long delivery times and significant customs duties can limit operational flexibility and increase inventory costs (Table 3).

Table 3. Unit costs and total procurement value (for one type of geotextile, 104,000 m²)

Procurement method	Quantity	Ex-works price	Customs duty	Transport costs	Discount	Unit price (€)	Total value (€)
From Hungary	104,000 m	0.35	0.000	0.002	0.00	0.352	36,645.0
From outside the EU	104,000 m	0.33	€0.000	€0.010	0.01	0.330	34,290.4
From China	104,000 m²	0.16	€0.006	€0.048	0.00	0.214	€22,239.0

Source: own compilation based on the database of qsd2 Kft.

Based on the data, the Chinese source can provide a cost advantage of nearly 40%. However, transport risks, advance payment obligations and longer replenishment times must be taken into account, which necessitate higher safety stock levels. This increases storage requirements and reduces financial liquidity, so the stability of the entire supply chain must also be assessed when making purchasing decisions.

Consignment Stock Management

Consignment stocking, which first appeared in the late 19th century in the agricultural and textile industries, is now a common solution in many industries, especially where consumption is unpredictable or cyclical. The essence of the model is that the supplier places the product at the buyer's premises, but ownership is only transferred at the moment of use or sale. This allows the buyer to remain liquid while ensuring the supply of materials, and the supplier to establish a longer-term relationship, even though they have to bear the cost of inventory and the associated risks. The focus of qsd2 Kft.'s inventory management is on increasing financial liquidity and operational flexibility. To this end, consignment agreements have been concluded with several suppliers in recent years. These have enabled the company to avoid excessive capital commitment in the area of geotextile stocking, while being able to respond more quickly to customer orders. With the introduction of the new system, orders can now typically be fulfilled within 2-4 working days instead of 2-3 weeks. Table 4 shows the main advantages and disadvantages of this model based on the practice of qsd2 Kft.

Table 4. Advantages and disadvantages of consignment stocking based on the example of qsd2 Kft.

Advantages	Disadvantages
Improved liquidity: capital tied up is reduced and cash reserves increase.	More expensive storage: qsd2 continues to use physical storage.
Reduced risk of stock shortages, improved service levels.	Requires more complex administration and record keeping.
Shorter delivery times, faster customer service.	Continuous, accurate communication between the parties is required.
Inventory risk (obsolescence, damage) is borne by the supplier.	Requires legal regulation to clearly establish ownership and liability.
Reduces the operational burden on the purchasing department (e.g., reordering can be automated).	The supplier's bargaining position may be weakened, especially in the case of stronger buyers.

Source: own compilation

With regard to the first research question (RQ1), it can be concluded that the use of the consignment stock model contributed significantly to strengthening the company's financial stability. The reduction in capital tied up and the

increase in cash reserves improved the liquidity position, while the reduction in the risk of stock shortages had a positive effect on customer satisfaction and service quality. However, the model requires more complex administration, legally regulated cooperation, and accurate communication, so its successful application requires significant organizational discipline and technological support. With regard to the second research question (RQ2), the results show that the conscious geographical diversification of the supplier network—combining domestic, EU, and Chinese partners—has helped to optimize procurement costs, increase delivery flexibility, and maintain security of supply. While Far Eastern purchases offered lower unit prices, they were associated with longer lead times and higher inventory levels, compared to the faster and more predictable logistics performance provided by domestic and EU partners. The combined, hybrid procurement model offered a solution to balance these challenges.

CONCLUSION

The results of the research confirm that conscious, strategic inventory management is a key factor in maintaining the long-term competitiveness and financial stability of small and medium-sized enterprises (SMEs). The case study of qsd2 Kft. clearly highlighted that inventory management is not merely an operational function, but a complex, multidimensional corporate management task that has a direct impact on liquidity, operational flexibility, customer service quality, and overall organizational efficiency. The handling of geotextiles—as special, heavy, and long-lead industrial products—is a particularly sensitive area where inventory decisions directly affect the company's cash flow and market responsiveness. The research showed that the introduction of the consignment inventory model at qsd2 Kft. measurably improved liquidity indicators, reduced capital commitment, and facilitated faster customer service. The model enabled the company to avoid excessive inventory accumulation while becoming more flexible in meeting customer demands. At the same time, the conscious diversification of the supplier network—a combination of domestic, European, and Chinese sources—effectively mitigated the supply risks arising from unilateral dependence, while creating opportunities to optimize price competition and flexibility. According to the results of the research, a geographically diversified supplier structure not only has a positive impact on cost levels, but also contributes to increasing procurement security, especially amid global market volatility and geopolitical risks.

In terms of practical usefulness, the example of qsd2 Kft. clearly demonstrates that a well-chosen inventory management strategy can directly improve financial performance and customer satisfaction. Consignment stocking has enabled the company to remain competitive in a rapidly changing market environment without compromising liquidity. In addition, the use of decision support systems, ERP integration, and digital record-keeping solutions may lead to further efficiency gains in the future.

However, the limitations of the research are also clear. As the analysis was based on a single company case study, the generalizability of the results is limited. The study did not cover a broader statistical analysis of quantitative indicators or a comparison of different industries. A further limitation is that the qualitative factors of supplier relationships—such as trust, willingness to cooperate, or innovation capacity—were only partially examined. These dimensions deserve deeper qualitative and quantitative analysis in future research.

A promising direction for future studies could be to explore the digitalization potential of the consignment stock model, with a particular focus on automated data sharing, IoT-based inventory tracking, and artificial intelligence-supported demand forecasting. A comparative analysis across different industries, such as construction, agriculture, or healthcare, is also warranted to explore the factors that determine the adaptability and economic efficiency of the model. The practical implications of the research clearly show that inventory management is a strategic advantage for SMEs if it supports not only operational efficiency but also long-term sustainability. The introduction of modern IT solutions, advanced forecasting models, and supplier evaluation systems could further increase companies' adaptability in the future.

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