Journal of civil engineering and transport **transEngin**

2025, Volume **7** Number **3** **ISSN 2658-1698, e-ISSN 2658-2120**

DOI: 10.24136/tren.2025.009

APPLICATION OF ABC AND XYZ METHODS TO INVENTORY MANAGEMENT OF AUTOMOTIVE SPARE PARTS AND CONSUMABLE MATERIALS

Jacek **Borowiak** [1]

[1] Casimir Pulaski Radom University, Faculty of Mechanical Engineering, Stasieckiego 54, 26-600 Radom, Poland,
e-mail: j.borowiak@urad.edu.pl, https://orcid.org/0000-0003-3548-1660

Reviewed positively: 10.06.2025

Information about quoting an article:
Borowiak J. (2025). Application of ABC and XYZ methods to inventory management in an automotive industry enterprise. *Journal of civil engineering and transport*. 7(3), 141-149, ISSN 2658-1698, e-ISSN 2658-2120, DOI: 10.24136/tren.2025.009

Abstract – This article explores the application of the ABC and XYZ classification methods in inventory management within the automotive industry. Effective inventory control is essential for ensuring supply chain resilience and cost optimisation in a sector characterised by high product variety and fluctuating demand. The objective of the study is to examine how combining demand-based (ABC) and variability-based (XYZ) analyses can support strategic decision-making in supply logistics. The methodology includes a theoretical review of inventory classification techniques, followed by a case study demonstrating the implementation of the ABC/XYZ matrix on a selection of automotive components. The results show that this cross-classification enables more precise inventory segmentation, enhances forecasting accuracy, and facilitates tailored inventory control strategies. For each inventory category defined by the matrix, specific management recommendations are proposed, addressing ordering policies, safety stock levels, and supplier coordination. The findings confirm that the integrated use of ABC and XYZ methods supports demand analysis, improves service levels, and reduces excess stock, thereby increasing operational efficiency. The study contributes to the ongoing development of data-driven approaches in inventory management and offers practical insights for practitioners in the automotive supply chain.
Key words – demand analysis, supply logistics, ABC method, XYZ method, inventory management
JEL Classification – C44, M11, L23, L62

INTRODUCTION

One of the fundamental areas of enterprise operations is the accumulation, maintenance, and replenishment of inventory. Inventory may take the form of raw materials, supplies, semi-finished products, components, or finished goods and is essential for the continuity of production, service, and commercial activities. Its creation may result from the need to secure production processes against potential future disruptions in supply chains, as well as from anticipated increases in prices or consumer demand.

Inventory accompanies material flows in all logistics processes. Depending on the phase of the process with which it is associated, inventory can be classified as follows [1]:
- procurement inventory (raw materials, supplies, semi-finished products, components) – corresponding to the procurement phase (procurement logistics),
- work-in-process inventory (semi-finished goods in the process of being manufactured) – corresponding to the production phase (production logistics),
- finished goods inventory – corresponding to the distribution phase (distribution logistics).

Activities such as storage, inventory protection, and related operations generate costs that enterprises would prefer to avoid. In some cases, excess inventory may become obsolete or deteriorate, as is often the case with food, cosmetics or pharmaceutical products. Surplus and unnecessary inventory held during the current period may result in significant capital being tied up, that could otherwise be allocated toward investments or other income-generating purposes. Instead of incurring such costs, these unused resources could be redirected, for example, toward improving employee competencies (e.g., training) or increasing wages. Consequently, enterprises strive to minimize inventory in order to keep them at the optimal level.

The ideal scenario would be one in which materials, components, and finished goods are delivered to their destination exactly when needed, in accordance with the just-in-time principle. However, due to the necessity of maintaining operational continuity, it is difficult to envision the complete elimination of inventory from enterprise activities. The risks associated with lack of availability or delays in delivery, production downtime, missed sales opportunities, and thus the potential loss of revenue and customers to competitors, are simply too great.

The necessity of maintaining inventory for production purposes is directly linked to dependent demand, which results from the structure of final products. When the number of finished goods to be produced is known - either as ordered or planned - and the materials or components required for their production are identified, it is possible to calculate the corresponding material requirements. These calculations inform both the order quantities and inventory levels maintained by manufacturing enterprises.

Production companies do not solely manufacture products in response to received orders. They often produce for stock in anticipation of future market demand. Similarly, commercial and service-oriented enterprises maintain inventory based on projected customer needs. This type of requirement is referred to as independent demand. It is inherently more difficult to predict, as it pertains to future events and therefore contains an element of uncertainty. Nonetheless, enterprises engage in the analysis and forecasting of independent demand. These forecasts form the basis for determining inventory levels, which are then maintained in warehouses for raw material and finished goods [2], wholesale and retail outlets, and workshops and service facilities across various industries.

The subsequent section of this article presents the application of the ABC and XYZ methods for analysing independent demand in a sample commercial enterprise within the automotive industry.

1. Analysis Using ABC and XYZ Methods

The procurement policy for materials intended for production or goods intended for sale should be guided by the significance of these materials or goods for the effective functioning of the enterprise. The ABC and XYZ methods are useful tools that help to determine this significance. The goal is to identify the group of materials whose shortage could, for instance, result in production stoppages, or goods whose unavailability could prevent the enterprise from fulfilling customer expectations. Ultimately, the purpose of applying these methods is to identify the materials and goods that generate the greatest financial benefits for the enterprise-those that yield high revenues and profits (ABC method) and are sold in large quantities (XYZ method).

It should be noted that the ABC/XYZ methods, which rely on data from extended time periods (e.g. annual sales revenue and product quantities sold), are particularly useful in situations where demand is quasi-stationary [3]. A different analytical approach should be considered when a product is in another phase of its life cycle – i.e. when demand exhibits a trend (increasing or decreasing), or displays cyclical or seasonal patterns. In such cases, future inventory levels should be adjusted accordingly using appropriate forecasting methods. An alternative approach may involve analysing data over a shorter time horizon (e.g. monthly or weekly), where the effects of seasonality or cyclicality are less pronounced. However, this would require more frequent analysis.

The ABC analysis enables the classification of resources (in terms of inventory management) based on factors such as shelf life, storage, and value. It is particularly applied when organizing products that differ in type but share a similar status, especially within a specific enterprise. To conduct such an analysis, a key common characteristic is identified — typically, this is the value of the item [2].

The criterion for classification into groups A, B, and C may be the volume of demand, production, or sales within a given period [4].

The division into these groups is based on Vilfredo Pareto's law, which assumes that 20% of causes are responsible for 80% of the effects in a given phenomenon. Accordingly, group A includes approximately 20% of the assortment items that account for around 80% of revenue (sales value). Group B consists of about 30% of products that generate moderate revenue (approximately 15% in total), while group C comprises the remaining 50% of products that generate the lowest revenue (approximately 5% in total) during the analysed period.

In the literature, one can find slightly different proportions, where group A products constitute about 10% of inventory items and their annual consumption is 70%-80%, group B products constitute 20% of all inventory items and amount to 10%-15% of the total annual consumption of inventory, while group C products constitute 70% of all inventory items and amount to 5%-10% of the total annual consumption [5-7].

The percentage-based division into groups is indicative and may be subject to minor modifications. It is not uncommon, particularly in distribution companies, for group A to comprise only 10–15% of the product assortment [4].

For logistics managers, the most critical products are those classified under group A, characterised by high value or a significant share in material costs. These items should be handled with particular care in the following areas [1]:

- market, pricing, and cost structure analysis,
- detailed preparation of purchase orders,
- precise internal distribution procedures,
- appropriate inventory level management,
- determination of safety stock levels.

The second method used by enterprises for demand analysis is the XYZ method, which serves as a complement to the ABC method.

The classification into groups X, Y, and Z is based on the variability of a given feature, such as sales revenue, order value (as in [7]), average demand (as in [5]), or simply the quantity of products sold during the analysed period (as in [4]). There are no rigid rules governing this classification. It depends on the results obtained (coefficients of variation or average demand between consecutive deliveries) and is tailored to the specifics of the industry.

Products classified under group X are characterised by regular demand (large sales volumes, low variability); group Y includes items with medium sales volumes and moderate demand variability; while group Z encompasses products sold sporadically or irregularly (low quantities, high demand variability).

This categorisation plays a significant role in forecasting sales using available statistical tools. For products in group X, forecasts can be made with a relatively high degree of accuracy. In contrast, forecasting for group Z products is virtually impossible due to the high risk of error [7].

A cross-analysis of the ABC and XYZ methods results in a matrix consisting of 9 groups [9], the main characteristics of which are presented in Table 1.

Table 1. Cross-analysis ABC/XYZ [9]

	A	B	C
X	AX High consumption value and high predictability	BX Medium consumption value and high predictability	CX Low consumption value and high predictability
Y	AY High consumption value and medium predictability	BY Medium consumption value and medium predictability	CY Low consumption value and medium predictability
Z	AZ High consumption value and low predictability	BZ Medium consumption value and low predictability	CZ Low consumption value and low predictability

When applying consumption value (e.g., revenue or profit) as the classification criterion in the ABC method and consumption volume in the XYZ method, the AX group emerges as the most critical for business operations. Products within this category are characterised by the highest values and volumes of consumption. Moreover, demand for these products is relatively easy to predict. Conversely, the opposite situation applies to the CZ group, which comprises products with low consumption value and volume, for which demand forecasting is difficult or virtually impossible.

The ABC and XYZ methods described above are universal tools that can be used in manufacturing (including assembly operations [9]), service and retail companies of various industries. They are used to manage inventories of a wide range of materials and products, such as cleaning supplies [2], toys [4], office supplies [11] and food [12], building materials [10, 13], cosmetics [14], chemicals [15] and medical [5-8] products, components used in aerospace production [16] and materials for the production of armored vehicles [17] and as shown in the below example, automotive parts and consumables.

Such analyses can be performed using basic information technology tools, such as Microsoft Excel, as illustrated in publications [4, 18]. This specific software was utilized in the example provided in the following section. This represents a low-cost and widely accessible solution. More advanced, albeit significantly more expensive, alternatives include integrated ERP (Enterprise Resource Planning) and WMS (Warehouse Management System) platforms. These systems simplify the execution of ABC/XYZ analyses by embedding the necessary computational procedures and algorithms, thus eliminating the need for users to possess in-depth technical knowledge. The primary argument in favour of using such digital systems lies in the scale of operations in real-world enterprises, where the number of stock-keeping units (SKUs) and associated data far exceeds the simplified example discussed above. Consequently, the manual effort required to perform such analyses increases substantially. Digital solutions allow for more efficient identification and classification of products into appropriate groups, thereby enabling timely and informed logistical decision-making.

2. ABC/XYZ Demand Analysis in the Automotive Industry

Like any other sector, the automotive industry possesses its own specific characteristics. Demand for certain consumables and spare parts for vehicles may be directly influenced by the sales volume of particular car makes and models. The greater the number of vehicles of a given make or model in use, the more consumables and spare parts are subject to wear and failure, and the more frequently such vehicles are statistically involved in road collisions or accidents, which necessitate repairs or part replacements. Conversely, some brands and models are more reliable than others. Therefore, assuming identical sales volumes for two different makes or models, the demand for spare parts for the less reliable one is likely higher.

Furthermore, the automotive industry includes both vehicle-specific and universally applicable products. For example, a particular engine oil, tyre, or headlight bulb may be compatible with a wide range of makes and models, leading to significantly higher demand compared to parts designed exclusively for a single brand — or even a single model.

Before proceeding with ABC and XYZ classification, it is necessary to consider the scope of the analysis. Should it encompass the entire product range offered for sale, or only a specific segment - for example, parts and components for a single brand that are sourced from multiple suppliers. Alternatively, the analysis may be performed on products from various brands, grouped by supplier, or limited to a single product category (e.g., engine oils or tyres from multiple manufacturers supplied by one or several distributors).

Delivery frequency also plays a crucial role. The categorisation into groups X, Y, and Z may differ significantly depending on whether deliveries occur daily, weekly, biweekly, or less frequently. Although the classification methods themselves are relatively straightforward, their practical application requires careful consideration and a nuanced understanding of the specific operational and market conditions.

Example

The automotive wholesale company operates both through a physical outlet and via mail-order sales. Its main clients include car repair workshops and service centres, transport companies, as well as individual retail customers. The company sources spare parts and consumable materials from a wide range of suppliers.

In order to reduce stock levels, a strategy was adopted to analyse products supplied by each supplier separately. Table 2 presents information on the annual sales of products ordered from one such supplier, along with the results of the ABC analysis. For the purposes of this simplified example, the list of supplied parts and components has been reduced to 20 items. It has also been assumed that deliveries are made on a weekly basis.

The group A includes 4 products (20% of the product range) with the highest revenue (each with a share above 10%, totalling about 78% of sales value). Group B includes 6 products (30% of the product range) with medium revenue (each with a share above 1% but less than 10%, totalling about 18%), and group C includes the remaining 10 products (50% of the product range) generating the lowest revenue (each with a share below 1%, totalling about 4%) in the analysed year.

The ABC classification method was applied to identify strategically important items based on sales value (revenue). The resulting grouping structure reflects the classical Pareto principle (80/20 rule), whereby a limited number of items generate a disproportionately large share of total revenue. The analysis suggests that Category A items require close attention in terms of supply continuity, demand forecasting accuracy, and the optimal management of safety stock levels.

Table 2. Data and calculation overview, incorporating group division in the ABC method

No.	Product	Annual sales [units]	Net price [PLN/unit]	Annual revenue [PLN]	Cumulative annual revenue [PLN]	Share in revenue	Cumulative share in revenue	Group
		a	b	a*b				
1	Front bumper	812	560	454720	454720	28,30%	28,30%	A
2	Front grille guard	754	395	297830	752550	18,54%	46,83%	
3	Rear bumper	373	720	268560	1021110	16,71%	63,55%	
4	Bumper bracket	522	440	229680	1250790	14,29%	77,84%	
5	Bumper grille	385	280	107800	1358590	6,71%	84,55%	B
6	Bumper reinforcement	625	92	57500	1416090	3,58%	88,13%	
7	Headlamp strip	609	92	56028	1472118	3,49%	91,62%	
8	Decorative grille strip	595	41	24395	1496513	1,52%	93,13%	
9	Side strip	454	48	21792	1518305	1,36%	94,49%	
10	Engine hood	23	905	20815	1539120	1,30%	95,79%	
11	Crossbar	65	156	10140	1549260	0,63%	96,42%	C
12	Bumper mount	310	31	9610	1558870	0,60%	97,02%	
13	Airflow guide	375	24	9000	1567870	0,56%	97,58%	
14	Protective strip	155	56	8680	1576550	0,54%	98,12%	
15	Radiator air guide	210	34	7140	1583690	0,44%	98,56%	
16	Grille frame strip	198	31	6138	1589828	0,38%	98,94%	
17	Engine hood hinge	90	56	5040	1594868	0,31%	99,26%	
18	Front emblem	115	38	4370	1599238	0,27%	99,53%	
19	Engine hood lock	25	154	3850	1603088	0,24%	99,77%	
20	Front air channel	85	44	3740	1606828	0,23%	100,00%	
			Total	1606828	Total	100,00%		

Considering that orders from the supplier are delivered once a week, data on weekly demand (between consecutive deliveries) was collected for the purpose of classifying products using the XYZ method. This allowed for determining its frequency of occurrence (Table 3).

Table 3. Weekly demand frequency distributions

No.	Product	Annual sales [units]	Weekly demand [units]																		
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
			Weekly demand frequency																		
1	Front bumper	812													1	2	7	13	15	11	3
2	Front grille guard	754												2	1	8	14	15	9	3	
3	Bumper reinforcement	625										2	6	10	15	11	6	2			
4	Headlamp strip	609										3	7	12	16	9	4	1			
5	Decorative grille strip	595								1		2	9	14	16	7	2	1			
6	Bumper bracket	522								2	6	10	14	12	6	2					
7	Side strip	454							4	7	12	13	10	4	2						
8	Bumper grille	385					2	2	10	13	13	8	4								
9	Airflow guide	375				1	2	6	4	15	15	5	4								
10	Rear bumper	373				1	2	5	8	13	12	8	3								
11	Bumper mount	310		1		2	5	10	14	12	7	1									
12	Radiator air guide	210		2	5	9	14	17	5												
13	Grille frame strip	198		2	5	13	18	10	3	1											
14	Protective strip	155	1	3	12	21	10	5													
15	Front emblem	115	1	11	21	14	5														
16	Engine hood hinge	90	2	18	24	8															
17	Front air channel	85	4	17	25	6															
18	Crossbar	65	10	22	17	3															
19	Engine hood lock	25	28	23	1																
20	Engine hood	23	29	23																	

In the next stage, the mean and standard deviation of the weekly demand values for each product were calculated, along with their coefficients of variation, which formed the basis for the classification into groups X, Y, and Z. The results of these analyses are presented in Table 4.

The division into groups X, Y, and Z in this case can be carried out based on the annual quantity of products sold, the average weekly demand values, or his variability. In this case, the XYZ analysis was implemented based on the variability of weekly demand. The classification criterion was the coefficient of variation (V_D), defined as the ratio of the standard deviation to the average weekly sales volume. This approach assesses demand predictability, which is a critical factor in selecting appropriate inventory replenishment strategies.

Based on this classification, Group X included 6 items characterized by high predictability and low demand variability (V_D < 15%) with a weekly demand exceeding 10 units. Group Y comprised 6 items with moderate variability (15% < V_D < 32%) and an average weekly demand between 4 and 10 units. Finally, Group Z consisted of 8 items with high demand variability (V_D > 32%) and irregular demand of less than 4 units per week.

Table 4. Data and calculation overview, incorporating group division in the XYZ method

No.	Product	Annual sales [units]	Avg. weekly sales [units]	Standard deviation [units]	Variation coefficient V_D	Group
		a	b=a/52	c	c/b	
1	Front bumper	812	15,62	1,33	8,52%	X
2	Front grille guard	754	14,50	1,36	9,41%	
3	Bumper reinforcement	625	12,02	1,43	11,94%	
4	Headlamp strip	609	11,71	1,38	11,76%	
5	Decorative grille strip	595	11,44	1,41	12,29%	
6	Bumper bracket	522	10,04	1,44	14,36%	
7	Side strip	454	8,73	1,51	17,29%	Y
8	Bumper grille	385	7,40	1,46	19,70%	
9	Airflow guide	375	7,21	1,60	22,20%	
10	Rear bumper	373	7,17	1,61	22,38%	
11	Bumper mount	310	5,96	1,55	25,94%	
12	Radiator air guide	210	4,04	1,28	31,76%	
13	Grille frame strip	198	3,81	1,25	32,91%	Z
14	Protective strip	155	2,98	1,11	37,28%	
15	Front emblem	115	2,21	0,96	43,26%	
16	Engine hood hinge	90	1,73	0,77	44,48%	
17	Front air channel	85	1,63	0,79	48,50%	
18	Crossbar	65	1,25	0,84	66,98%	
19	Engine hood lock	25	0,48	0,54	112,73%	
20	Engine hood	23	0,44	0,50	113,38%	

The final stage of the analysis involves combining the ABC and XYZ methods, resulting in a cross analysis, presented in Table 5.

Table 5. Cross-analysis ABC/XYZ - 9-group matrix

	A	B	C
X	AX: Front bumper, Front grille guard, Bumper bracket	BX: Bumper reinforcement, Headlamp strip, Decorative grille strip	CX:
Y	AY: Rear bumper	BY: Bumper grille, Side strip	CY: Bumper mount, Airflow guide, Radiator air guide
Z	AZ:	BZ: Engine hood	CZ: Grille frame strip, Protective strip, Front emblem, Engine hood hinge, Front air channel, Crossbar, Engine hood lock

Group AX consists of 3 products exhibiting low demand variability and high predictability. These items are characterized by high sales volumes, which justifies the need for precise procurement planning and maintaining a high level of availability. It is recommended to apply a continuous review inventory system based on the reorder point (ROP) [19], alongside the optimization of safety stock levels. To enhance operational efficiency, automating of the ordering process should also be considered.

Group AY includes 1 product with high economic importance but moderate demand variability and predictability. In this case, increasing the safety stock level is advisable to mitigate the risk of stockouts. The implementation of advanced demand forecasting models, incorporating seasonality and trend analysis, is also recommended, along with to regular updates of sales data. A periodic review policy [20] is appropriate for such items, offering flexibility in inventory replenishment.

Group AZ contains no products, which may indicate an effective company strategy aimed at avoiding items with high revenue potential but low demand stability. Such products pose a high risk of either excess inventory or stockouts. If such items were present, an individualized inventory management approach would be warranted, with an emphasis on pull-based strategies-replenishment driven by actual demand and maintaining **low inventory levels**. The effectiveness of this approach depends on a highly flexible supply chain and short lead times, which may pose a challenge in industries with complex and lengthy logistics structures.

Group BX includes 3 products of moderate economic importance and high demand stability (low variability and high predictability). In this case, the safety stock can be minimized. A simplified min-max replenishment system [17] is recommended, particularly effective under stable lead times. The classic economic order quantity (EOQ) model can also be implemented. To reduce logistics costs, order consolidation within this product group may also be considered.

Group BY comprises 2 products with moderate sales value and average demand stability. Inventory control for these items should involve more frequent inventory reviews and adjustment of order parameters in response to changing market conditions. Maintaining a moderate safety stock level is advised, and the use of demand forecasting tools should be implemented.

Group BZ contains 1 product with moderate economic value but high demand variability. Due to difficulties in demand forecasting, it is advisable to limit inventory levels and avoid advance bulk ordering. Flexible inventory strategies such as make-to-order or pull-based replenishment are recommended to minimize the risk of overstocking.

Group CX includes no products in the analyzed sample. However, if items with low revenue contribution but high demand stability were identified, it would be appropriate to consolidate orders at longer intervals intervals or based on the **min-max strategy**. This approach reduces operational costs while maintaining adequate availability.

Group CY includes 3 products with low economic importance and moderate demand predictability. For this group, it is advisable to consider assortment reduction and to minimize inventory levels. In the event of demand occurrence, it is recommended to replenish stock through periodic review and a flexible pull-based approach.

Group CZ contains the largest number of items-7 in total. These products are characterized by low revenue contribution combined with high demand variability and low predictability. Such items can incur disproportionate inventory holding costs relative to their economic benefits. Therefore, demand-driven strategies such as pull-based systems or dropshipping are advisable, along with inventory minimization or even withdrawal of the product from the sale offer. However, customer expectations for assortment breadth should also be considered, which may justify maintaining small stocks of selected low-rotation items. Decisions in this area should be supported by individual profitability assessments.

CONCLUSIONS

Identifying products that generate the highest revenue or profit and are sold in significant quantities is one of the most important tasks for management. Equally important is the identification of those items whose sales are marginal, infrequent, and yield only limited profit. Managerial efforts should be focused on ensuring sufficiently high, yet not excessive, inventory levels of the former. In contrast, the latter may consume resources unnecessarily - including capital, warehouse space, human and equipment resources (such as handling, storage, packaging, maintenance, protection, and safeguarding of stock) - and generate costs that are disproportionate to the benefits they bring. Maintaining large quantities of such items lacks economic justification.

The analysis conducted in the article is an example of implementing strategic inventory management in an automotive industry company by segmenting the assortment according to value (ABC method) and demand predictability (XYZ method). The use of ABC/XYZ cross analysis allows for optimization of warehouse decisions, reducing inventory costs and improving customer service levels.

The subject of the analysis was an automotive wholesaler conducting both stationary and mail order sales. Institutional customers (car repair workshops, transport companies) and individual customers create a diversified demand structure, which implies the need for effective inventory management. The company makes deliveries on a weekly basis, which determines the stock replenishment cycle and influences the choice of inventory management strategy.

The integration of the ABC and XYZ methods facilitates a dynamic and adaptive inventory management strategy, allowing businesses to respond effectively to fluctuating market conditions. In manufacturing, retail, and service sectors, these methods support the efficient planning and organization of ordering, storage, and sales processes. By aligning inventory levels with evolving demand, companies can minimize inventory holding costs while enhancing their overall competitiveness and financial performance.

This paper contributes to the field of inventory management by applying the ABC and XYZ methods in a cross-analysis framework tailored to the automotive industry. It presents a unique application of these methods, demonstrating how logistics managers can leverage these tools to improve inventory control. Unlike some previous studies that treat ABC and XYZ analyses separately, this paper underscores the value of combining both methods to create a more comprehensive inventory management system. Additionally, the paper highlights the importance of considering specific market conditions, such as the delivery frequency and demand variability, when implementing these methods, offering a more tailored approach compared to general inventory management strategies. The practical application of these methods in real-world scenarios-such as the automotive wholesale sector-demonstrates their relevance and utility in optimizing inventory processes.

The study provides insights into the specific challenges of the automotive industry, such as the impact of vehicle reliability, part compatibility and product life cycle stages on demand forecasting. By providing a tailored approach that accounts for these variables, the paper offers valuable insights into how inventory managers can more accurately forecast demand and optimize stock levels, increasing the relevance of the analysis for practitioners in the automotive sector.

ZASTOSOWANIE METOD ABC I XYZ DO ZARZĄDZANIA ZAPASAMI W PRZEDSIĘBIORSTWIE BRANŻY MOTORYZACYJNEJ

Artykuł przedstawia zastosowanie metod klasyfikacyjnych ABC i XYZ w zarządzaniu zapasami w branży motoryzacyjnej. Skuteczna kontrola zapasów jest kluczowa dla zapewnienia odporności łańcucha dostaw oraz optymalizacji kosztów w sektorze charakteryzującym się dużą różnorodnością produktów i zmiennym popytem. Celem badania jest analiza, w jaki sposób połączenie analizy wartości zużycia (ABC) z analizą zmienności popytu (XYZ) może wspierać podejmowanie decyzji strategicznych w logistyce zaopatrzenia. W artykule przedstawiono przegląd teoretyczny technik klasyfikacji zapasów oraz studium przypadku ilustrujące wdrożenie macierzy ABC/XYZ na wybranych komponentach motoryzacyjnych. Wyniki pokazują, że klasyfikacja krzyżowa umożliwia bardziej precyzyjną segmentację zapasów, poprawia trafność prognozowania oraz pozwala na opracowanie zróżnicowanych strategii zarządzania zapasami. Dla każdej z kategorii wyodrębnionych w macierzy ABC/XYZ zaproponowano konkretne zalecenia dotyczące polityki zamówień, poziomu zapasu bezpieczeństwa i współpracy z dostawcami. Wyniki potwierdzają, że zintegrowane wykorzystanie metod ABC i XYZ wspiera analizę popytu, zwiększa poziom obsługi klienta i redukuje nadmiar zapasów, przyczyniając się do wzrostu efektywności operacyjnej. Artykuł wnosi wkład w rozwój podejść opartych na danych w zarządzaniu zapasami i dostarcza praktycznych wskazówek dla menedżerów logistyki w branży motoryzacyjnej.

Słowa kluczowe: analiza popytu, logistyka zaopatrzenia, metoda ABC, metoda XYZ, zarządzanie zapasami.

REFERENCES

[1] Abt S. (2001). *Zarządzanie logistyczne w ćwiczeniach*, Wydawnictwo Akademii Ekonomicznej w Poznaniu. 79-82.
[2] Jóźwiak A., Guciewski Ł. (2017). Zastosowanie analizy ABC w magazynach wysokiego składowania. *Gospodarka Materiałowa i Logistyka*. 5/2017.
[3] Kabanova T., Malakhova T., Zenkova Z. (2022). ABC-XYZ inventory analysis accounting for change points. International *Journal of Logistics Systems and Management*. 41(1/2), 59–76. https://doi.org/10.1504/IJLSM.2022.120981.
[4] Krzyżaniak S. (2002). *Podstawy zarządzania zapasami w przykładach. Biblioteka Logistyka*, Inst. Logistyki i Magazynowania. 19-27.
[5] Amer H.Y., Jawad M.K. (2023). Inventory Analysis Using the ABC-VED Matrix - Applied Research in Al-Zawraa State Company. *International Journal of Professional Business Review*. 8(5). Article e01508. https://doi.org/10.26668/businessreview/2023.v8i5.1508.

[6] Taddele B.W., et al. (2019). ABC-VEN Matrix Analysis of the Pharmacy Store in a Secondary Level Health Care Facility in Arbaminch Town, Southern Ethiopia. *Journal of Young Pharmacists*. 11(2). 182–185. https://doi.org/10.5530/jyp.2019.11.38.
[7] Al-Najjar S. M., Jawad M. K., Saber O. A. (2020). Application of ABC-VED Matrix Analysis to Control the Inventory of a Central Pharmacy in a Public Hospital: A Case Study. *International Journal of Science and Research*. 9(1). 1328-1336. https://www.ijsr.net/archive/v9i1/ART20204180.pdf. (accessed 07.03.2025).
[8] Wolak M. (2016). Zastosowanie analiz ABC i XYZ w controllingu sprzedaży. *Prace Naukowe Uniwersytetu Ekonomicznego we Wrocławiu*. *Rachunkowość a controlling*. No. 440, Wyd. Uniwersytetu Ekonomicznego we Wrocławiu. 545-555. https://doi.org/10.15611/pn.2016.440.52 (accessed 12.03.2025).
[9] Hadaś Ł., Klimarczyk G. (2010). Wyniki analizy ABC/XYZ w przedsiębiorstwie montażowym o wysokim stopniu kastomizacji – studium przypadku. *Logistyka*. 1/2010.
[10] Stević Ž., Bećirović M. (2021). ABC/XYZ Inventory Management Model in a Construction Material Warehouse. *Alphanumeric Journal*. 9(2). 325–334. https://doi.org/10.17093/alphanumeric.1052034.
[11] Trubchenko T. G., et al. (2020). Application of ABC and XYZ Analysis to Inventory Optimization at a Commercial Enterprise. *SHS Web of Conferences*. 80. 01007. https://doi.org/10.1051/shsconf/20208001007.
[12] Arree W., et al. (2020). Application of ABC classification analysis technique for inventory management of food categories: A case study XYZ department store. *RMUTSB Academic Journal* (*Humanities and Social Sciences*). 5(2). 153–166. https://so05.tci-thaijo.org/index.php/rmutsb-hs/article/view/242389 (accessed 20.03.2025).
[13] Katsko A., Gola A. (2024). System zarządzania zapasami z wykorzystaniem metody ABC – case study na przykładzie przedsiębiorstwa produkcyjnego z branży budowlanej. Zarządzanie Przedsiębiorstwem. *Enterprise Management*. 27(1), 13-23. https://doi.org/10.25961/ent.manag.27.01.03.
[14] Defindal I.P., Saputra N. (2023) Applying Machine Learning on ABC-XYZ Inventory Model Using Multivariate and Hierarchical Clustering. Proceedings of the 6th International Conference on Vocational Education Applied Science and Technology (*ICVEAST 2023*). Advances in Social Science, Education and Humanities Research. Vol. 799. 322–334. https://doi.org/10.2991/978-2-38476-132-6_30.
[15] Devarajan D., Jayamohan M. (2016). Stock Control in a Chemical Firm: Combined FSN and XYZ Analysis. Procedia Technology. 24. 562–567. https://doi.org/10.1016/j.protcy.2016.05.111.
[16] Yung K.L., et al. (2021). Inventory classification system in space mission component replenishment using multi-attribute fuzzy ABC classification. Industrial Management and Data Systems. 121(3). 637-654. https://doi.org/10.1108/IMDS-09-2020-0518.
[17] Hernandoko N., Laksono, P.W. (2023). Inventory Control Using ABC Classification and Min-Max Stock Method in The Manufacture of Armored Vehicle Body Hull at PT XYZ. E3S Web of Conferences. 8th *International Conference on Industrial, Mechanical, Electrical and Chemical Engineering* (*ICIMECE 2023*). 465. Article 02009. https://doi.org/10.1051/e3sconf/202346502009.
[18] Szymczak M. (red.) (2011). *Decyzje logistyczne z EXCELEM*. Difin. 175-188.
[19] Lukiman A. D., Richard R. (2020). Analytical Hierarchy Process (AHP), Economic Order Quantity (EOQ), and Reorder Point (ROP) in Inventory Management System. *ComTech: Computer, Mathematics and Engineering Applications*. 11(1). 29-34. https://doi.org/10.21512/comtech.v11i1.5746.
[20] Tagaras G., Vlachos D. (2001). A Periodic Review Inventory System with Emergency Replenishments. *Management Science*. 47(3), 415-429. https://doi.org/10.1287/mnsc.47.3.415.9770.