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Differentiation of stocks by the ABC approach in the synergy of the order penetration point of the logistics chain

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Keywords: logistic chain, order penetration point, costs, optimization, ABC method.
Abstract: This research summarizes the results of the scientific discussion about the logistic chain and its order penetration point and influences on the costs of stocks. The main goal of this article is to point out determining the order penetration point of the logistics chain and differentiation of stocks according to importance from the point of view of optimizing costs and securing liquid financial resources. The object of the research was the industrial company. In this research, methods focused on using ABC analysis and Pareto analysis. The results of this research show 5 order penetration points (OPP1-OPP5) and a Push and Pull system to manage material flows for order penetration point of the logistics chain at the customer's order point. Cost optimization was solved by classifying the stocks into categories A, B, and C which is an important fact for planning and inventory management. ABC method divided 100 types of inventories with costs €5 million into categories A, B, C. Critical types of stocks in category A represents the group of stocks 38,92,7,52,13,54,90 that were reduced. This reduction of critical stocks led to the release of funds tied up in stocks. This change has a positive effect on the financial side of the company's cash flow – financial flows.

1 Introduction

Inventory represents the assets of a business and forms an important element of supply- customer chains that ties up a significant number of financial resources. Inventory, on the one hand, ensures the required level of customer service – continuous flow and enough inventory of stock items in the warehouse, on the other hand, the size of the inventory should be optimized so as not to allocate too many funds to the inventory because optimal stocks are based for lean production and effective information logistic system [1]. Supply chain management creates synergy between the optimization of stocks and checking the suppliers [2].

The goal of this paper is to determine the order penetration point disconnection point of the logistics chain and differentiation of stocks according to importance from the point of view of optimizing costs and liquid financial resources. Inventory management is part of supply chain management. Companies need strategy inventories in warehouses to fulfil customer demand. These strategy inventories create costs and it means financially no liquid items [3]. Inventory management partially mediates the relationship between managerial competence and financial performance [4]. The logistics chain (Figure 1) is therefore a sequence of individual elements through which the material flow passes from the supplier of raw materials to the final customer [5]. The mapping and quantification of material, information, and financial flows and their visualization is the basis for understanding and systematic work with the so-called disconnection point of the logistics chain.

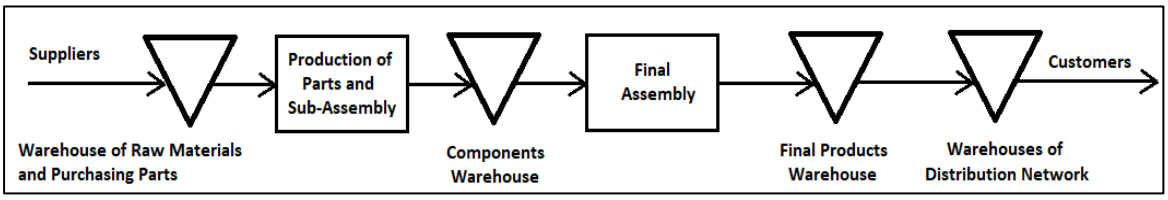

Figure 1 Logistics chain (own source)

The horizontal structure (Figure 2) of logistics management is the division of the material flow into a part managed according to stocks, the production program, based on demand forecasts and managed according to customer orders [6]. The inventory control system based on the stock level gives the impetus to place a production order or to place an order for stock replenishment now when the stock has fallen below the so-called signal or order level [7]. Control according to the program is an extension of the previous system by a time interval. The impulse, the creation of which is dependent on the immediate level of stocks, is here replaced by a time program - a stock replenishment plan [8]. Based on the demand forecast, the immediate time course of the immediate stock is determined. The necessary data for entering production orders and/or orders is then derived from this process. When managing according to customer orders, assembly, production, or even the prior procurement of some materials and parts begins only after the receipt and confirmation of the order.

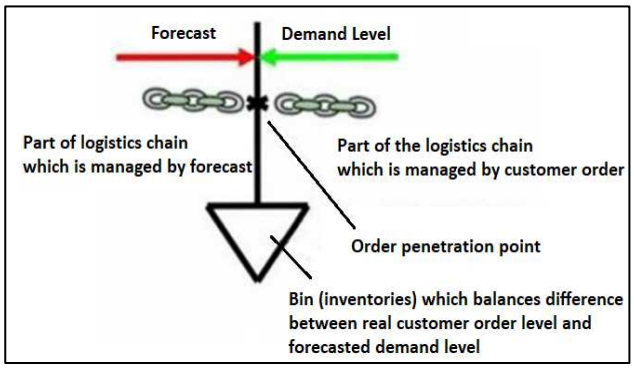

Figure 2 Order penetration point of the logistics chain (own source)

The limit between the two parts of the material flow forms the point where the logistics chain is disconnected by the customer's order. At this point, independent demand is transformed into dependent demand. The location of the decoupling point indicates how deep independent demand that is, customer orders penetrate the company's material flow.

2 Methodology

The goal of this paper was to point out and determine the order penetration point of the logistics chain and this order penetration point is analysed first by characteristics and then by structure and material flow management. Results are presented in the analytical part of this paper. Since the order penetration point in the logistics chain also affects the number of costs, we used the ABC method of inventory differentiation according to significance and importance to optimize costs. The principle of ABC analysis (Figure 3) is derived from the Pareto rule, defined by the Italian economist Vilfredo Pareto. Only 20% of the possible causes cause 80% of the consequences. Pareto's law is therefore a method that formulates the basis of inventory management. It is a method of classifying the product portfolio according to various criteria of importance and ultimately makes a large product portfolio transparent.

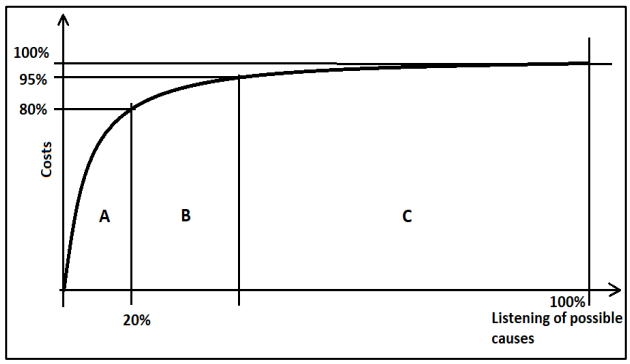

Figure 3 Pareto analysis and Lorenz curve (own source)

The principle of ABC analysis defines 3 categories of inventory: inventory category A, inventory category B, inventory category C. Group A includes a relatively small number of elements with a high share of the total value, the share of B elements corresponds to its number, and group C includes the remaining elements of the set with a small share of the total value. Group C tends to be the most numerous. Files of this type can be encountered very often. Based on the value expression of stock and quantity, we classify group A - cost 80%, quantity of stock 20%, group B - cost 15%, stock 30%, group C - cost 5%, quantity of stock 50%.

3 Result and discussion

This order penetration point is analysed first by characteristic and then by structure and material flow management.

The order penetration point is therefore the place in the logistics chain in which the dispersion of demand for the given product is balanced. The order penetration point is the place where the customer's order "runs in" and thus starts and controls the subsequent material flow. The order penetration point by customer order always refers to a certain combination of product and market. This means to a certain product (or family of products, product line) and to a certain circle of customers in a certain territory. Determining the location of the order penetration point in the material flow is a very important decision of the company's management – more precisely material flow management. The disconnection point by the customer's order is an important location of the disconnection stock, which ensures the satisfaction of independent demand. Random fluctuations in customer demand are captured in it through the safety stock. Stochastic methods are used to control the replenishment of inventory at the order penetration point.

The order penetration point of the logistics chain "disconnects" the entire logistics chain into two parts: to the part controlled by the plan, which is burdened by the fact of demand uncertainty, the consequence of which is the necessity to maintain a safety stock at the order penetration point, to the part driven by specific demand, which is characterized by the fact that there are no stocks in the system to manage material flow that are at risk of "unsaleability"; everything here is only a matter of capacity balancing and planning. The order penetration point by customer order always refers to a certain combination of product and market. This means to a certain product (or family of products, product line) and to a certain circle of customers in a certain business territory. Determining the location of the order penetration point in the material flow is a very important decision of the company's management. We have analysed the possible ways of the order penetration point of the logistics chain and describe 5 ways for the order penetration point in the logistics chain (Figure 4).

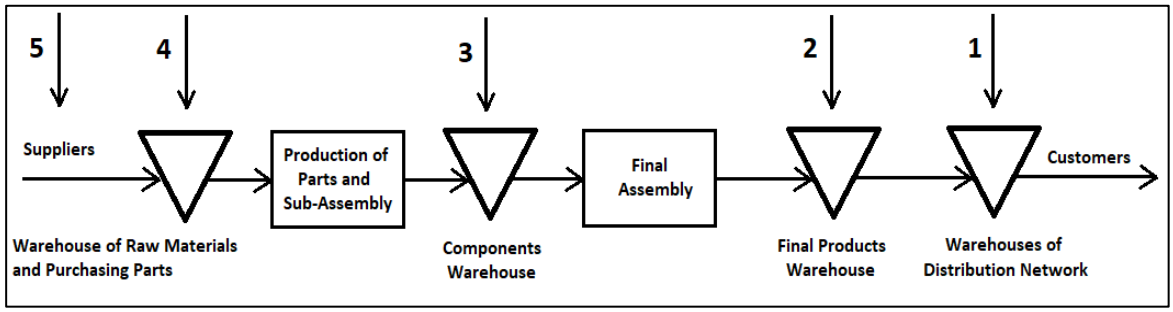

Figure 4 Possibilities of order penetration point of the logistics chain (own source)

OPP1 – order penetration point in distribution warehouses, final products are shipped to the network of distribution warehouses, and to customers. This order penetration point assumes the existence of a distribution network. The customer's order enters the distribution warehouse.

OPP2 – order penetration point in the warehouses of finished products; the final products are concentrated in one place in the company. The customer's order penetrates the warehouse of finished products of the production plant, or into the central warehouse, from where the products are then dispatched.

OPP3 – order penetration point in assembly warehouses prior to final assembly represents the location of the order penetration point somewhere within the manufacturing and assembly process.

OPP4 – order penetration point in the warehouses of raw materials, materials, and semi-finished products at the manufacturer, only raw materials, materials, and purchased parts are stored; the customer's order penetrates up to this stock. Production starts only based on a specific order; each order is usually implemented as a separate production order.

OPP5 – order penetration point in the supplier's warehouses, stocks are not permanently maintained at all; the procurement of raw materials, materials, and purchased parts begins only after receiving the customer's order. Each order represents a specific project.

Characteristics of order penetration points in the logistics chain (Table 1).

Table 1 Order penetration point characteristic (own source)

Point	Place	Activity
OPP1	Distribution warehouses	Production and expedition to the warehouse
OPP2	Warehouses of finished products	Production to the warehouse
OPP3	Warehouses prior to final assembly	Construction to order
OPP4	Warehouses of raw materials	Production to order
OPP5	External warehouses	Purchase and manufacture to order

The order penetration point by the customer order separates areas of the material flow with a different management method and thus also with different requirements for planning methods and with a different nature of decision-making (Figure 5). **"Downstream"** material flow control - from the point of disconnection to the market, activities are managed based on received confirmed customer orders. Controlling the material flow **"upstream"** from the decoupling point to the suppliers is

activity control based on plans compiled based on an independent demand forecast.

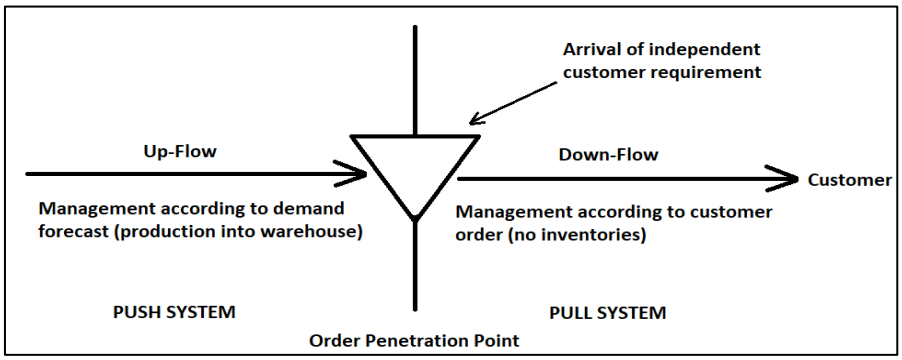

Figure 5 Order penetration point of the logistics chain at the customer's order point (own source)

"Downstream" material flow control: the main decisions concern the coordination of all activities for specific orders. Allocation of capacities is determined by accepted orders. Production or assembly batches are usually equal to the size of the order. In this area of material flow, production is usually controlled using PULL systems. **"Upstream"** usually, a master production plan is drawn up, which represents the production program for replenishing the stock of items at the order penetration point by the customer's order. Based on this plan, the dependent need for subordinate items in the materials, and parts are then calculated. Capacities are planned for estimated future demand. It is produced in batches; the effort is to make the best possible use of capacity. In this area of material flow, production is mostly managed using PUSH systems.

When determining the optimal location of the disconnection point for the customer's order, it is important to monitor factors such as the time interval of delivery to the customer, the number of costs associated with delivery, the speed of processing the order, the provision of service delivery services, which ultimately has a significant impact on customer satisfaction.

The further the order penetration point is located from the customer, the more the cost of holding safety stock is saved. On the other hand, however, the overall reaction time to a customer's order is, on the contrary, longer the further the order penetartion point is from the customer. The closer the order penetration point is to the customer, the greater the risk of unsalability and high inventory holding costs. On the other hand, the more the production has the character of custom production, the less the mentioned risks are, but the reaction to specific customer requirements is slower, and the production costs increase (Figure 6).

For optimizing stocks in industrial companies is important to combine the ABC method with the EIQ method (entry, item, quantity). This combination aims to understand the relationship between the order types and quantities. It helps to clarify the customer's order quantity and the proportion of orders [9]. Implementation of several inventory control methods (ABC, XYZ, EIQ, Pareto analysis) is efficient to improve the smooth operation of trading companies and industrial companies to solve problems such as inventory shortages and on the other hand excess unrequired inventory [10]. The EOQ model, SIM model, SC inventory model, and SC structure model are models for optimizing stocks. Those models sustainable inventory management in supply chains. Those models are the instrument for new research in the inventory areas for the future [11].

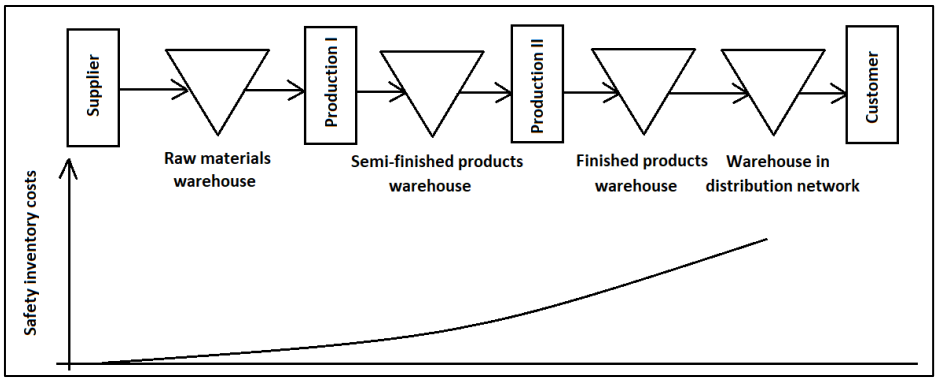

Figure 6 Amount of costs to the location of the order penetration point of the logistics chain (own source)

The inventory management system of flows is a very essential component for each company. Inventory creates assets of the company and the most important resource of the production. The inventory management and control system relates to methods of ABC analysis, VED analysis, and EOQ analysis [12]. In modern business today, companies that hold large numbers of inventory items do not find it economical to make policies for the management of individual inventory items. The method of grouping and inventory control available in traditional ABC has a lot of disadvantages which were solved in the new innovative model ABC. This ABC model is solved by the mathematical model by the Benders decomposition and the Lagrange relaxation algorithm has an objective function to maximize the net profit of items in stock. Limitations such as budget and even inventory shortages are considered too [13].

Application of ABC method and Pareto analysis of stocks

We applied ABC analysis in an industrial enterprise, in which the order penetration point of the logistics chain is monitored according to the OPP5 type. There are 100 types of inventories with a value of €5 million in the external warehouse, which tie up the company's financial resources, and the company has a problem with cash flow and the liquidity indicator. This problem was solved by optimizing stocks in warehouses according to the ABC method, which determined A, B, C categories of stocks (Table 2) according to the amount of costs and the number of stock types stored. Category A consists of 10 types of stocks, which means 10% of the ratio of stocks from the total stocks in the company, which represent a high value of supply and storage costs at the level of 80% of total costs, which represents €3.9 million, which tie up the company's financial resources, thus affecting solvency of the company.

Table 2 ABC classification – method (own source)

Category	Number of type of stocks	Structure of stocks (%)	Costs of stocks (€)	Structure of costs (%)
A	10	**10%**	3 999 425	**80%**
B	36	**36%**	741 263	**15%**
C	54	**54%**	259 312	**5%**
SUM	100	100%	5 000 000	100%

Given that category A represents critical stocks, it is necessary to analyse them in detail. We found out which specific types of stored stocks are in category A from financial accounting, we determined the amount of costs related to individual types of stored stocks. From the 10 types of items, it is possible to determine problematic items based on Pareto analysis. In stock category A, the 10 item types were as follows (Table 3): 38,92,7,52,13,54,90,14,12,30. We assessed these inventory items from financial accounting on accounts 501 01-501 10 analytical records in the company's accounting.

Table 3 Pareto analyse of Category A (own source)

Type of stocks	Costs of stocks (€)	Structure (%)	Cumulative structure (%)
38	525790	**13**	13
92	448874	**11**	24
7	443876	**11**	35
52	435722	**11**	46
13	427940	**11**	57
54	416191	**10**	67
90	392277	**10**	77
14	384605	**10**	87
12	368011	**9**	96
30	156139	**4**	**100**
SUM	3999425	100%	

In order to calculate the critical items, it was necessary to arrange the types of inventory from the highest cost item to the lowest cost item, then to determine the share of individual items of inventory in percentage terms, while the total share is 100%, the share determined in this way was then accumulated in order to be able to graphically represent the Lorenz curve, which sets us critical inventory cost items. Based on the graphic representation, we will determine the stock value with a column chart as a Pareto analysis and insert the cumulative value of the percentage expression of the individual types of stock into the chart. At the point where the Lorenz curve intersects 80% on the y-axis, the perpendicular to the x-axis will represent the critical inventory type interval (Figure 7).

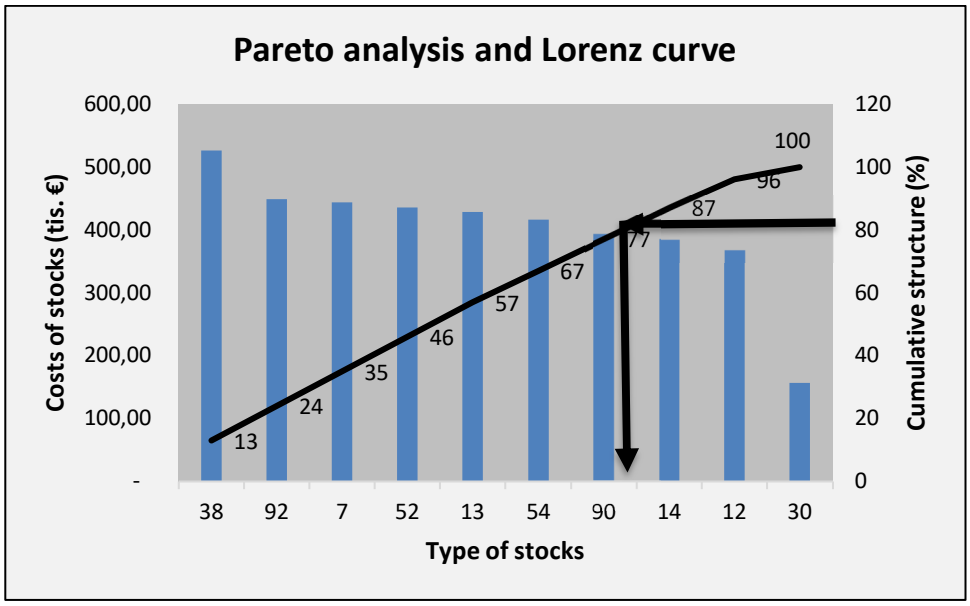

Figure 7 Pareto analysis and Lorenz curve (own source)

Based on the Lorenz curve, we can conclude that the critical types of stocks in category A represent the group of stocks 38,92,7,52,13,54,90. Within this category A, the 80/20 rules of inventory group 14,12,30, which represent costs of €156,139 to €384,605, do not belong to the Pareto. Costs in other inventory groups are growing and represent a tie-up of financial resources in the company. Systematic inventory management practices (IMPs) introduce an important and effective success factor for industrial companies [14]. The dynamic development of Industry 4.0 is focused on the implementation of new technologies that implement new methods, and instruments for inventory management systems [15].

4 Conclusions

Optimum inventory management in the company is an important part of the strategic management of the company because supply management is the main business process in the value chain, on which other processes such as production, sales, service, etc. depend. Stocks represent the company's property, which is gradually consumed according to the requirements of the production process and whose value is gradually reflected in the value of the finished product. The results of this research were to point out determining the at-order penetration point of the logistics chain and differentiation of stocks according to importance from the point of view of optimizing costs and securing liquid financial resources. Results of this research shows on 5 order penetration points (OPP1-OPP5) and Push and Pull material flow management system for order penetration point of the logistics chain at the customer's order point. Cost optimization was solved by classification the stocks in category A, B, C that is important fact for planning and inventory management. ABC method divided 100 types of inventories with costs €5 million into categories A, B, C. Critical types of stocks in category A represent the group of stocks 38, 92, 7, 52, 13,54, 90 that were reduced. This solution introduces one alternative the release of funds tied up in stocks. This alternative has a positive benefit on the financial side in the area of cash flow. Using Pareto analysis for stock optimization is an instrument, which means benefits in material flow management.

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References

[1] PEKARČÍKOVÁ, M., TREBUŇA, P., KLIMENT, M.: Digitalization effects on the usability of lean tools, *Acta logistica*, Vol. 6, No. 1, pp. 9-13, 2019. https://doi.org/10.22306/al.v6i1.112

[2] ZWAIDA, T.A., PHAM, □., BEAUREGARD, Y.: Optimization of inventory management to prevent drug shortages in the hospital supply chain, *Applied Sciences*, Vol. 11, □o. 6, pp. 1-20, 2021. https://doi.org/10.3390/app11062726

[3] PLI□ERE, D., BORISOV, A.: □ase Study on Inventory Management Improvement, *Information Technology and Management Science*, Vol. 18, □o. 1, pp. 91-96, 2016. https://doi.org/10.1515/itms-2015-0014

[4] OROBIA, L.A., □AKIBUUKA, J., BA□A□UKA, J., AKISIMIRE, R.: Inventory management, managerial competence, and financial performance of small businesses, *Journal of Accounting in Emerging Economies*, Vol. 10, □o. 3, pp. 379-398, 2020. https://doi.org/10.1108/JAEE-07-2019-0147

[5] SOHAIL, N., SHEIKH, T.H.: A study of inventory management system case study, *Journal of Advanced Research in Dynamical and Control Systems*, Vol. 10, Special Issue 10, pp. 1176-1190, 2018.
[6] LACHVAJDEROVÁ, L., KÁDÁROVÁ, J.: Industry 4.0 Implementation and Industry 5.0 Readiness in Industrial Enterprises. *Management and Production Engineering Review*, Vol. 13, No. 3, pp. 102-109, 2022. https://doi.org/10.24425/mper.2022.142387
[7] MARKULIK, Š., TURISOVA, R., NAGYOVA, A, VILINSKY, T., KOZEL, R., VASKOVICOVA, K.: Production Process Optimization by Reducing Downtime and Minimization of Costs, In: Goonetilleke, R.S., Xiong, S., Kalkis, H., Roja, Z., Karwowski, W., Murata, A. (eds) Advances in Physical, Social & Occupational Ergonomics, AHFE 2021, Lecture Notes in Networks and Systems, Vol. 273, Springer, Cham, pp. 220-227, 2021. https://doi.org/10.1007/978-3-030-80713-9_29
[8] RYBÁR, R., GABÁNIOVÁ, Ľ., RYBÁROVÁ, J., BEER, M., BEDNÁROVÁ, L.: Designing a tool for an innovative, interdisciplinary learning process based on a comprehensive understanding of sourcing: a case study, *Processes*, Vol. 10, No. 1, pp. 1-20, 2022. https://doi.org/10.3390/pr10010009
[9] MA, L.: Study on Inventory Optimization of Chain Supermarkets Based on EIQ-ABC Analysis Method. *Accounting and Corporate Management*, Vol. 4, No. 1, pp. 75-83, 2022. https://doi.org/10.23977/acccm.2022.04
[10] IMARAH, T.S., JAELANI, R.: ABC Analysis, Forecasting And Economic Order Quantity Implementation To Improve Smooth Operation Process. *Dinasti International Journal of Education Management And Social Science*, Vol. 1, No. 3, pp. 319-325, 2020. https://doi.org/10.31933/dijemss.v1i3.149
[11] BECERRA, P., MULA, J., SANCHIS, R.: Sustainable inventory management in supply chains: trends and further research, *Sustainability*, Vol. 14, No. 5, pp. 1-19, 2022. https://doi.org/10.3390/su14052613
[12] NIRMALA, D.A.R., KANNAN, V., THANALAKSHMI, M., GNANARAJ, S.J.P., APPADURAI, M.: Inventory management and control system using ABC and VED analysis, *Materials Today: Proceedings*, Vol. 60, pp. 922-925, 2022. https://doi.org/10.1016/j.matpr.2021.10.315
[13] ABDOLAZIMI, O., SHISHEBORI, D., GOODARZIAN, F., GHASEMI, P., APPOLLONI, A.: Designing a new mathematical model based on ABC analysis for inventory control problem: A real case study, *Operations research*, Vol. 55, No. 4, pp. 2309-2335, 2021. https://doi.org./10.1051/ro/2021104
[14] AHMAD, K., ZABRI, S.M.: The mediating effect of knowledge of inventory management in the relationship between inventory management practices and performance: The case of micro retailing enterprises, *Journal of Business and Retail Management Research*, Vol. 12, No. 2, pp. 83-93, 2018. https://doi.org/10.24052/jbrmr/v12is02/tmeokoimitrbimpaptcomre
[15] SANIUK, S., GRABOWSKA, S., STRAKA, M.: Identification of Social and Economic Expectations: Contextual Reasons for the Transformation Process of Industry 4.0 into the Industry 5.0 Concept, *Sustainability*, Vol. 14, No. 3, pp. 1-20, 2022. https://doi.org/10.3390/su14031391

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