

INVENTORY MANAGEMENT IN THE SMART COMPANY INDUSTRY 4.0

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Abstract

Industry 4.0 is a concept that means the integration of intelligent machines, systems and introducing changes in production processes, aimed at increasing production efficiency and introducing the possibility of flexible changes in the assortment of products. Industry 4.0 is focused on continuous improvement of production processes. This is a turnaround in the production control methodology, as the growing expectations of customers in the modern market cause that along with the increase in production efficiency, the product is customized. In this trend, the customer decides about the product, personalizing it as much as possible in the best possible way. These are new challenges in the field of inventory management. The aim of the article is to present the method of calculating the optimal amount of the cost of a rotating stock in a production enterprise with an unevenly distributed demand.

Keywords: Industry 4.0, inventory management, Economic Size of Order, rotating stock

1. INTRODUCTION

In a modern, highly competitive production environment, production companies face the challenge of dealing with large amounts of data, the need to make quick decisions (even outside the workplace) and the flexibility of production processes (personalized product) [1]. The contemporary nature of production is shaped by changing the paradigm from mass production to production at the customer's request. Industry 4.0 (naming used since 2010). Industry 4.0 marks the fourth industrial revolution in which it is assumed that it is a vision of intelligent factories built of intelligent cyber-physical systems. The implementation of this idea should enable the development of intelligent production systems which, in addition to the aforementioned autonomy, will have the features of self-configuration, self-control and self-education [2].

Strong competition and growing customer expectations in the modern market mean that along with the increase in production efficiency, product customization takes place, i.e. the production of products in which the customer decides about the product. At the same time, the price of the product should be close to the price of products produced in mass production. This is exactly what the industry 4.0 concept provides, which assumes the creation of a fully integrated system of suppliers, producers and clients creating the so-called. cyber-physical CPS systems (Cyber-Physical Systems), which are open sociotechnical systems, capable of implementing a number of functions and actions imposed by production, logistics or management. This situation brings new challenges in the area of inventory management [7].

As a result, production speed will increase by around 30 % and productivity by at least 25 %. At the same time, complaints will be eliminated and material saving will be noticeable. A characteristic feature of Industry 4.0 will be fast and individual production for the customer's needs, not cheap and massive [8].

Changes in production processes will only be possible if proper tools for rapid redefinition of production are guaranteed, for which the company's logistics department must be prepared [6].



Industry 4.0 is changing the way we work across the supply chain. Using AI, sensors and Internet of Things (IoT) technology, a smart and data-driven distribution centre can be developed. For example, by cross-referencing enterprise resource planning (ERP) systems with consumer trends data [7-9].

Stocks are one of the components of the analysis of management efficiency in the production process **Chyba! Nenalezen zdroj odkazů.** One of the most important elements of logistic processes at every stage of functioning of production enterprises, i.e. in procurement, production and distribution - are stocks. Thanks to them, materials flow in an efficient manner and can also play an important role in situations of risk and uncertainty.

The primary goal of inventory management is the ability to react responsibly to changes in demand, but at the same time lowering the maintenance of inflated stocks. It can also be included that, with regard to quality, a certain level of customer service, both internal and external, can be provided. Another important goal is to avoid excess and bottlenecks in the production process by tracking the current and future demand for all necessary goods [8-10].

The most important thing in stock management is the ability to make four important decisions. The first one is to indicate the materials in which stocks will be maintained. The next decisions are: determining the method of inventory control and the size of the batch of deliveries or production, as well as determining how long the order will be processed. For such decisions it is very important to distinguish types of demand [11-16].

Industry 4.0, referred to as the upcoming future of production, raises the question of what changes companies and managers are waiting for?

The aim of the article is to present the method of calculating the optimal amount of the cost of a rotating stock in a production enterprise with an unevenly distributed demand.

2. MANAGEMENT OF ROTATING STOCK IN UNEVENLY DISTRIBUTED DEMAND - METHODOLOGY

The rotary inventory is primarily associated with regular consumption, as well as with supplies that are intended to cover anticipated and current demand. It is renewed on the basis of the information level and periodic review [15, 16, 17]. Under the Industry 4.0 concept, enterprises will be forced to dynamically change the size and type of the rotating stock.

The article uses data from an enterprise dealing in production from the automotive industry. Due to the limited possibility of publishing the data in the article, the details allowing to identify the examined enterprise were omitted.

The study shows how the cost of the rotating stock will look when the demand is unevenly distributed, what happens in the case of customizing the product. The adopted period will be three months, because the planned demand is unevenly distributed (every quarter) during the year. **Table 1** shows the demand in each quarter. Wilson's formula for the Economic Size of the Order was also used in the calculation, but taking into account that the adopted period is not a year, but quarters.

Table 1 Demand distribution throughout the year

Volume of demand: quarter I	0.15	15 %
Volume of demand: quarter II	0.2	20 %
Volume of demand: quarter III	0.3	30 %
Volume of demand: quarter IV	0.35	35 %

The following relationships were used [18]:

- $EWZ = \sqrt{\frac{2PP_o * k_u}{C * u_o}}$, (Economical Volume of Order) (1)

- $KZR = \frac{PP_o}{EWZ} * k_u + u_o * C * 0,5 * EWZ$ (The cost of a rotating inventory in a given quarter) (2)

where:

PP_k - volume of planned demand in each quarter ($k = I, II, III$ or IV);

k_{ui} - cost connected with order, i.e. one delivery of one assortment

C_i - unit price of particular assortment,

$$\sum KZR' I + \sum KZR' II + \sum KZR' III + \sum KZR' IV \quad (3)$$

$$KZR' = 87922.16 \text{ (Total cost)}$$

$$KZR = \sum KZR I + \sum KZR II + \sum KZR III + \sum KZR IV \quad (4)$$

$$KZR = 69417.79$$

$$\text{Difference: } 18504.36$$

When comparing total costs in both cases, it can be noticed that costs in the second situation increased by approx. 27 %.

Figure 1 shows the calculation of the cost of a rotating stock for uneven distributed demand. In contrast, in **Figure 2** (for comparison) the calculation of the cost of the rotating stock would be presented if unequal demand in quarters was omitted. At the same time, the value of the Economic Order Size for individual raw materials was assumed for a whole year.

From the calculations presented it is clear that if the demand is not evenly distributed (which is usually the case in production adjustment), the size of the economic order should be calculated for each period so as not to incur unnecessary costs associated with the purchase of raw materials and / or maintenance / preservation of stocks.

3. CONCLUSION

Inventory management is one of the basic logistics functions of a production company, including planning, organization, implementation and control of these phases of goods flow. In connection with the customization of production that takes place in the Industry 4.0 concept, this type of management must be highly flexible.

From the analysis of the literature on the subject, it can be concluded that rotating stocks are the most important in inventory management. Their validity is due, among other things, to the fact that such stocks are necessary for the proper functioning of the company and show regular delivery and sales. The application of the presented method of calculating the rotational stock rotation allows for wise management, elimination of unnecessary costs - which can be extremely useful in the era of the Industry 4.0 concept and the need to create a smart enterprise.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Stock	Piece	Quantity	Price [euro]	Value [euro]	PP Demand planned for a year [unit]	PP*demand in I quarter [unit]	PP*demand in II quarter [unit]	PP*demand in III quarter [unit]	PP*demand in IV quarter [unit]	EWZ _I Economical order volume in I quarter [unit]	EWZ _{II} Economical order volume in II quarter [unit]	EWZ _{III} Economical order volume in III quarter [unit]	EWZ _{IV} Economical order volume in IV quarter [unit]	KZRI Relating stock cost in I quarter [euro]	KZRI Relating stock cost in II quarter [euro]	KZRI Relating stock cost in III quarter [euro]	KZRI _{IV} Relating stock cost in IV quarter [euro]			
2	S1	1	30	144,5	4335	1560	234	312	468	546	139	161	197	213	1510,75	1744,47	2136,53	2307,71			
3	S2	1	75	65	4875	3900	585	780	1170	1365	329	379	465	502	1602,09	1849,93	2265,76	2447,23			
4	S3	1	15	197,5	2962,5	780	117	156	234	273	84	97	119	129	1248,90	1442,11	1766,21	1907,73			
5	S4	1	23	134,95	3103,85	1196	179	239	359	419	126	146	179	193	1278,35	1476,41	1807,86	1952,74			
6	S5	1	40	89,25	3570	2080	312	416	624	728	205	237	290	313	1370,99	1583,08	1938,87	2084,22			
7	S6	1	25	151,84	3796	1300	195	260	390	455	124	143	176	190	1413,72	1632,42	1999,30	2159,48			
8	S7	1	63	44,64	2812,32	3276	491	655	983	1147	363	420	514	555	1216,83	1405,08	1720,86	1858,75			
9	S8	1	28	104,39	2922,92	1456	218	291	437	510	158	183	224	242	1240,53	1432,44	1754,38	1894,94			
10	S9	1	43	74,3	3194,9	2236	335	447	671	783	233	269	329	356	1296,96	1497,60	1834,18	1981,14			
11	S10	1	93	42,45	3947,85	4836	725	967	1451	1693	453	523	640	692	1441,72	1694,75	2038,89	2202,26			
12															13620,84	15727,99	19262,78	20806,18			
13																					
14																					
15																					
16																					
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18																					
19																					

Figure 1 Calculation of the cost of rotating stock for uneven distributed demand [own elaboration based on 19]



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
	Stock	Piece	Quantity	Price [euro]	Value [euro]	PP Demand planned for a year [unit]	PP* demand in I quarter [unit]	PP* demand in II quarter [unit]	PP* demand in III quarter [unit]	PP* demand in IV quarter [unit]	EWZ Economical Volume of Order [unit]	KZRI Rotating stock cost in I quarter [euro]	KZRII Rotating stock cost in II quarter [euro]	KZRIII Rotating stock cost in III quarter [euro]	KZRIV Rotating stock cost in IV quarter [euro]			
20																		
21	S1	1	30	144,5	4335	1560	234	312	468	546	360	2242,93	2340,45	2535,49	2633,01			
22	S2	1	75	65	4875	3900	585	780	1170	1365	849	2378,53	2481,94	2688,77	2792,19			
23	S3	1	15	197,5	2962,5	780	117	156	234	273	218	1854,17	1934,79	2096,02	2176,64			
24	S4	1	23	134,95	3103,85	1196	179	239	359	419	326	1897,89	1980,41	2145,44	2227,86			
25	S5	1	40	89,25	3570	2080	312	416	624	728	529	2035,43	2123,92	2300,92	2389,41			
26	S6	1	25	151,84	3796	1300	195	260	390	455	321	2098,86	2190,12	2322,63	2463,88			
27	S7	1	63	44,64	2812,32	3276	491	655	983	1147	938	1806,57	1885,11	2042,20	2120,75			
28	S8	1	28	104,39	2922,92	1456	218	291	437	510	409	1841,75	1921,82	2081,97	2162,05			
29	S9	1	43	74,3	3194,9	2236	335	447	671	783	601	1925,53	2009,25	2176,68	2260,40			
30	S10	1	93	42,45	3947,85	4836	725	967	1451	1693	1169	2140,43	2233,50	2419,62	2512,68			
31												20222,10	21101,32	22859,76	23738,98			
32																		
33																		
34																		
35																		
36																		

Figure 2 Calculation of the cost of the rotating stock for the same Economic Value of Order [own elaboration based on 19]

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