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AN ORIGINAL METHOD FOR CALCULATING INVENTORY TURNOVER PERIOD (ITP) FOR LOGISTICS OPTIMIZATION IN INTERNET BUSINESS

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The Internet has become a platform for innovation and startup development, providing young companies with the opportunity to quickly implement their ideas and achieve growth on a global level. The use of Internet technologies allows businesses to automate and optimize business processes, resulting in increased operational efficiency.

Logistics is crucial for Internet business and is necessary for its successful operation. In Internet business, where products are often sold online and delivered to customers, logistical aspects become even more important. Logistics plays a vital role in Internet business, where the speed and efficiency of supply and delivery processes are critical.

In intensive business operations, one of the most important factors affecting effectiveness is Inventory Turnover Period (ITP). ITP is one of the key indicators for evaluating and improving logistical processes in Internet business, as well as for ensuring customer satisfaction and reducing costs.

Another important indicator is the Inventory Turnover Ratio (ITR). The inventory turnover ratio is essential in internet business due to the following key aspects:

1. **Capital turnover speed**: The inventory turnover ratio determines how quickly goods are converted into cash. In internet business, capital often depends on product sales, so reducing the inventory turnover period helps companies utilize their capital more efficiently and increase profits.

2. **Reduction of financial expenses**: A long inventory turnover period can lead to increased expenses for storing goods and other operational costs. Faster inventory turnover helps reduce these costs and increase profitability.

3. **Customer satisfaction**: Internet businesses typically compete for customers based on service quality and delivery speed. A shorter inventory turnover period helps ensure fast delivery and customer satisfaction, often leading to repeat purchases and loyalty.

4. **Planning and forecasting**: Knowledge of the inventory turnover ratio helps internet businesses better plan supply, orders, and development strategies, allowing companies to adapt more easily to changes in demand and market conditions.

Therefore, the inventory turnover ratio in internet business affects financial efficiency, customer satisfaction, and overall company success. Rapid inventory turnover contributes to increased profitability and competitiveness in internet business.

The organic connection and balanced integration of the concepts of 'internet business,' 'logistics,' and 'inventory turnover' in business management enable optimization of the entire company's operations and achievement of business efficiency, especially when it involves online sales of goods.

Logistics, in turn, helps companies strike a balance between maintaining sufficient inventory to fulfill orders and avoiding excessive stocks, which can tie up cash flow. These factors significantly impact inventory turnover efficiency and turnover ratio.

Overall, these aspects shape the success of business operations and revenue growth from commercial activities.

The use of indicators that characterize inventory turnover plays a very important role in internet business, as they allow assessing inventory management efficiency and the financial productivity of the company. It is particularly important for companies with significant investments in inventory. Even a slight change in inventory turnover brings significant cash flow release and additional profit.

Numerical characteristics of inventory turnover include the inventory turnover ratio (ITR) and the inventory turnover period (ITP) of goods.

The inventory turnover ratio (ITR) indicates how many times the average inventory turnover occurs within a specified period.

The inventory turnover period (ITP) or turnover cycle duration is the length of time it takes for one turnover to occur, expressed in days or months.

A significant number of works by Ukrainian and foreign authors are dedicated to developing an efficient scheme for calculating the inventory turnover period and determining the inventory turnover ratio [3-5].

Generally, there are several calculation schemes for the inventory turnover ratio and turnover period. One of the most common methods is based on the calculation using the average inventory value, which is used to determine both the turnover ratio and the turnover period [6].

The classical scheme for calculating these indicators based on the average value includes the following steps:

1. Calculation of the average inventory value over a specified period (which could be the number of days in a month, quarter, or year). To do this, the inventory values at the beginning and end of the period are added, and the result is divided by two.

2. Calculation of the sales volume for the same period. This could be the total sales amount for the period or the number of units of goods sold during the period.

3. Calculation of the inventory turnover ratio. It is determined as the ratio of the sales volume to the average inventory value. As mentioned above, this indicator characterizes how many times the inventory was sold and replaced with new stock during the reporting period.

4. Calculation of the inventory turnover period. This indicator allows estimating how long it takes to replenish the inventory. It is determined as the ratio of the number of days in the period to the inventory turnover ratio.

Based on this, the following expression can be written for the inventory turnover ratio(ITR) and the inventory turnover period (ITP) of goods:

$$\mathbf{R}_t = \frac{V_{sales}}{V_{aver.bal.}} \quad (1)$$

$$\mathbf{P}_t = = \frac{T_{пер.}}{R_{t.}} = \frac{V_{aver.bal.} x T_{per.}}{V_{sales}} \quad (2)$$

where V_{sales} - is the volume of sales for the selected period;

$V_{aver.bal}$ - is the average balance of commodity stocks for the selected period;

T_{per} - is the term of the selected settlement period.

In addition, there are other calculation methods. For example, the Days Sales of Inventory (DSI) method and the Months of Sales (MOS) method [6]. It is worth reminding that the higher the inventory turnover ratio or the shorter the turnover period, the faster a company transforms its inventory into sales, indicating its efficiency.

As we can see, these indicators are integral and averaged over a certain period of time and are calculated with relative accuracy.

From the presented schemes, including the classical one, it is evident that calculating the average inventory value over a specific period based on the relation of "adding the inventory values at the beginning and end of the period and dividing the obtained value by 2" does not introduce significant errors in the calculation of the inventory turnover ratio and turnover period, only if the fluctuations in the inventory balance during this period are minor and not subject to sharp changes.

However, these methods may have significant errors if the company experiences large fluctuations in demand for a particular product or if certain company products (not all and not always forming the basis of the product range) have a seasonal or periodic nature.

If the presence of a product in the company's inventory is seasonal or periodic, calculating the average inventory will be, at best, incorrect, and at worst, will lead to incorrect assessment of the state of the inventory and, consequently, financial losses for the company.

Such a situation can be vividly illustrated by the following model example.

Figure 1 shows the graphs of changes in the inventory balance at the company's warehouse and the movement of goods due to sales, respectively, for a periodic product.

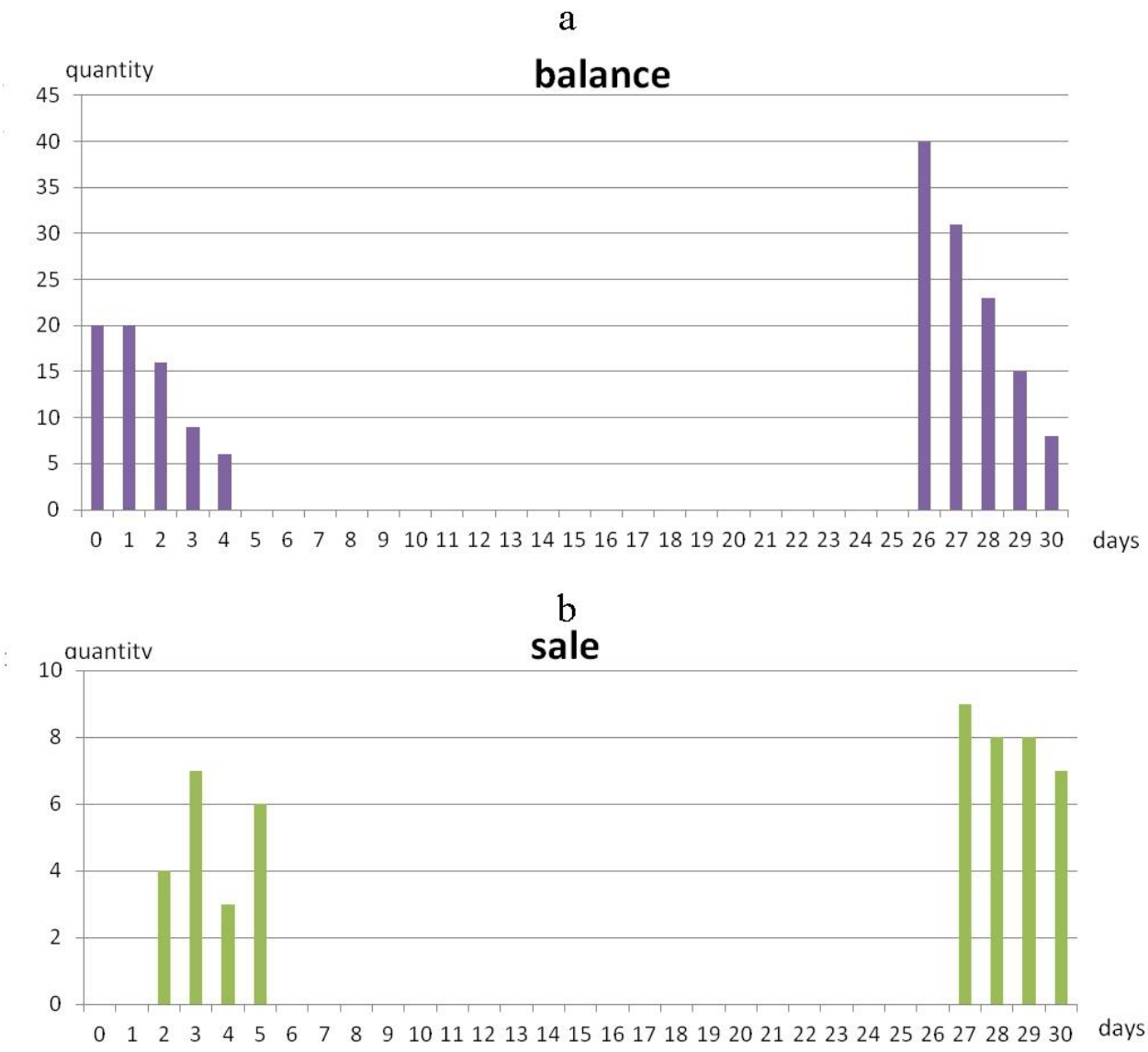

Fig. 1. Dynamics of goods movement in the warehouse: a) change of the goods balance in the warehouse; b) dynamics of product sales by day during the month.

As seen from the graphs, the product was present in the warehouse for the first 4 days. The inventory was completely sold out. Then there was a break in the delivery of goods for 22 days. And it appeared again in the warehouse 4 days before the end of the period.

It is evident that with such demand for the product, the inventory turnover ratio must be quite high (the speed of sales, on average, implies the sale of purchased goods within approximately 4-5 days). Thus, the inventory turnover ratio for the reporting period (when calculated for a month - this is 30 calculation days) should be close to 6-7, and the turnover period, accordingly, 3-4 days.

However, if we apply the classical calculation scheme (1) - (2), we will obtain the values of the inventory turnover ratio $\mathbf{R}_t$ =3.71 and the turnover period $\mathbf{P}_t$ =8.09 days.

It is visually evident that an error arises due to incorrect calculation of the average balance (the average value from the initial and final balances) in the company's warehouse. This error leads to a significant mistake in determining the turnover period by more than 2.5 times.

From the above, we can conclude that the classical scheme for calculating the turnover period is incorrect and requires significant improvement.

The authors propose a method to address this issue. This method can be called "event-based" because it involves time-fixed "events" of purchasing and selling goods within a time interval during which the turnover period and inventory turnover ratio are calculated.

To simplify, let's consider the movement of goods in a wholesale trading organization. For such an organization, the product's lifecycle consists of the following simple stages:

- Purchasing the product from the supplier and delivering it to the company's warehouse;
- Pre-sale preparation;
- Selling the product to the buyer.

The speed of selling the product to customers, considering the quantity of goods sold, will be considered the turnover period of this item.

To explain the operation of the turnover calculation algorithm, let's return to the definition of the term "turnover period of goods." In most studies, authors provide the following simple definition of this term: "Turnover is the time it takes for goods received in the warehouse to be converted into money and returned to circulation."

All calculations to determine the inventory turnover ratio or turnover period of goods, in one way or another, are aimed precisely at this goal - to determine the time for returning "frozen" funds invested in goods back into circulation. This allows efficient management of the company's assets.

Thus, the presence of the "event" of freezing funds in goods - is the purchase of goods and their delivery to the company's warehouse. If the goods are not sold, then the funds invested in these goods will remain frozen until the end of the reporting period. In this case, the inventory turnover ratio will be zero, and the turnover period will be infinite.

Returning funds to circulation becomes possible through the sale of goods. This is the second "event," from which a portion of the funds returns to circulation and starts working further.

If all the goods are sold on the same day as the day of purchase, the inventory turnover ratio will be equal to the number of calendar days in the reporting period (for example, the number of days in the given month for monthly calculations or 7 days for weekly calculations), and the turnover period, accordingly, will be 1 day.

To understand how the movement of funds invested in purchased goods occurs, let's consider two simple examples observed with real goods in a trading organization.

For comparison, we will provide two possible situations for goods depending on the speed of their realization during sales (Fig. 2).

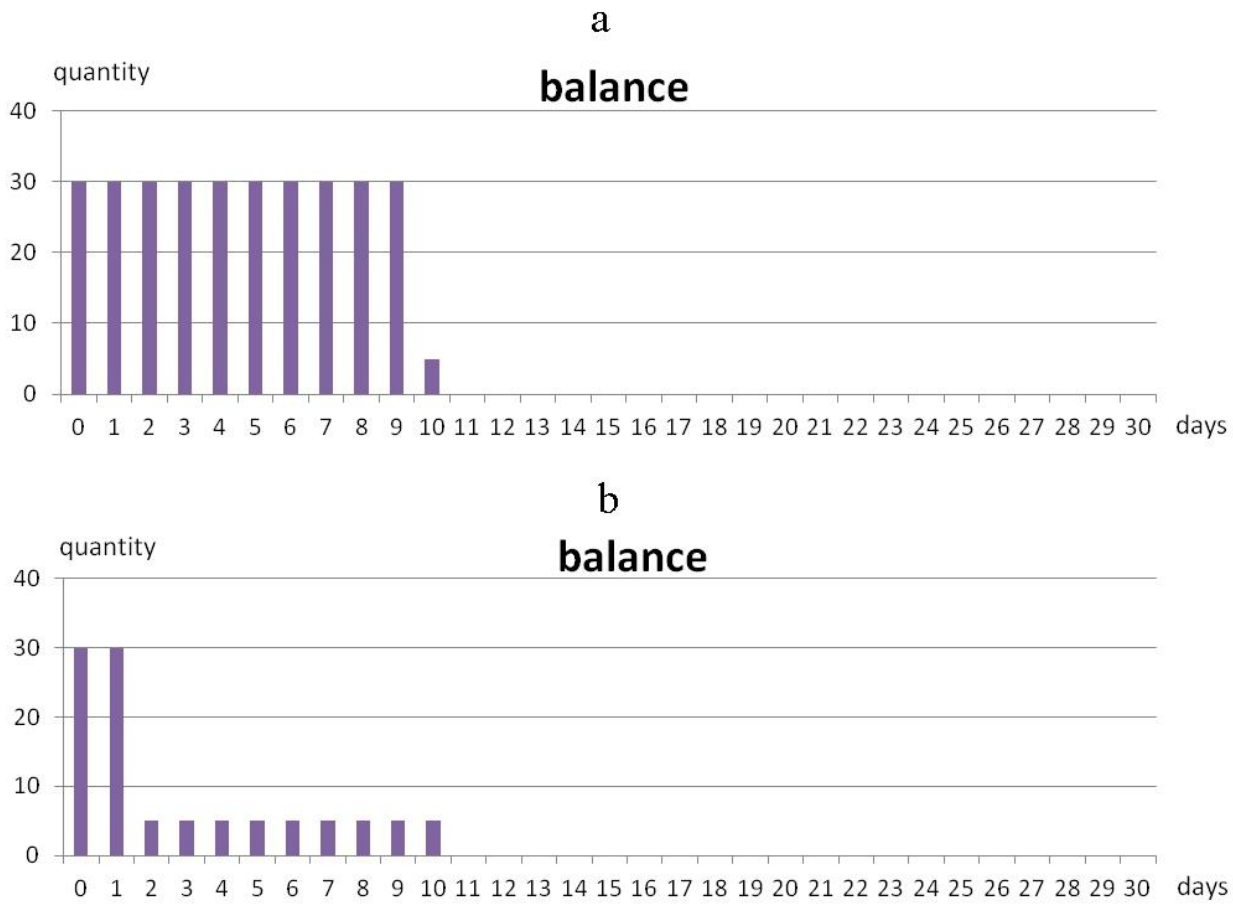

Fig. 2. An example of the movement of goods depending on the speed of sale: a) low speed of sale; b) high speed of sale.

As seen from the figure, in both the first (Fig. 2a) and the second (Fig. 2b) cases, the goods are present in the company's warehouse for 10 days. However, in the first case, the sale of goods occurred on the last 9th and 10th days, while in the second case, the main sale of goods was made on the second day of the reporting period (month), and the final small balance was sold on the 10th day.

Clearly, the turnover period of the goods in these two cases will differ significantly from each other.

In the first case, the turnover period will approach 10 days, while in the second case, it will be slightly more than 2-3 days. This is because in the first case (Figure 2a), the funds were "frozen" in the goods for 9 days, and only then did the sale of goods from the company's warehouse begin.

In the second case (Fig. 2b), the sale of goods started on the second day of the reporting period, and a significant portion of the "frozen" funds in the goods (25 out of 30 units were sold) returned to circulation. In this case, obviously, the turnover period will be significantly shorter.

To calculate the turnover period and turnover ratio, one needs to operate with the sum of monetary funds, as both the sold goods and the remaining inventory must be accounted for using the cost price of the goods.

If the cost price of the goods does not undergo significant fluctuations during the reporting period, then when relating the volume of funds returned from sales (the quantity of goods sold multiplied by the cost price) to the volume of funds concentrated in inventory (the product of the quantity of goods in inventory by the cost price), the cost price will simply cancel out in the expression for the inventory turnover ratio.

In the example provided, for simplicity, when calculating the turnover period of goods, we will operate with the quantity of goods assuming it was one batch of goods in which the cost price per unit did not change.

Then, as seen from the equation for the turnover period (2) for the classical calculation scheme, in the numerator, there is the product of the quantity of units of average inventory for the entire reporting period (the period of "freezing" monetary funds in the average inventory), and in the denominator, there is the quantity of goods sold during this period. And for both the first (2a) and the second (2b) cases, the classical scheme will give the same value for the turnover period of goods $\mathbf{P_t}$ =15 days.

However, monetary funds were "frozen" for only 9 days (in the first case, Fig. 2a) before the first sale of goods, after which only one day remained with a small "frozen" balance. And in the second case, even less time elapsed - only two days passed before the first significant sale. After this, almost all monetary funds returned to circulation!

Of course, the classical calculation scheme does not work here. It simply cannot be used in these cases.

The calculation algorithm provided by the authors is simple and seems self-evident. It is necessary to consider the timing of the "events" of purchasing and selling goods.

There is only one non-trivial feature. The time intervals for calculation need to be counted in reverse, from the moment of the "event" to the end of the reporting period.

These events correspond to the beginning of the "freezing" of monetary funds in the goods and, accordingly, the second important moment - the return of monetary funds to circulation. When buying goods, it is necessary to count the period of "freezing" of monetary funds from the moment of purchase to the end of the reporting period. And when selling goods, it is necessary to calculate the period of "returning" (the start of work) of monetary funds to circulation - from the moment of sale also to the end of the reporting period. Only when selling, this will be a negative operation with respect to "freezing". Funds from the moment of sale return to circulation and work until the end of the reporting period. Essentially, part of the funds is unfrozen.

So, we obtain a somewhat complex yet effective formula for calculating the turnover period, considering N "purchase events" and M "sales events" of goods:

$$P_t = \frac{\text{Q-ty}_{\text{bal.}} \times \text{T}_{\text{per.}} + \sum_{\text{i}}^{N} \text{Q-ty purch}_{\text{i}} \times (\text{Date}_{\text{end}} - \text{Date.purch}_{\text{i}}) - \sum_{j}^{\text{M}} \text{Q-ty purch}_{j} \times (\text{Date}_{\text{end}} - \text{Date.sale}_{\text{i}})}{\sum_{\text{j}}^{\text{M}} \text{Q-ty goods}_{j}} \quad (3)$$

where $\text{Q-ty}_{\text{bal.}}$ - is the quantity of goods in the warehouse balance at the beginning of the period

$T_{per.}$ - is the number of days of the settlement period
$Q - ty\ purch_i$ - is the quantity of goods of the purchase i
$Date.purch_i$ - is the date of the purchase i
$Q - ty\ goods_j$ - is the quantity of product of the sale j
$Date.sale_i$ - is the date of the sale j
$Date_{end}$ - is the end date of the period

In the numerator, we sum up the initial inventory of goods in stock and the quantity of purchased goods, multiplied, respectively, by the "freezing" periods of cash for each "purchase event". It is understood that the initial inventory is "frozen" for the entire accounting period since it exists from the first day of the period. The plus sign indicates the freezing of cash in goods. From this amount, we subtract the sold goods, multiplied by the "return" period of funds into circulation, also for each "sales event". In this case, the minus sign characterizes the return of part of the cash into circulation.

In the denominator, as in the classical scheme, the quantity equals the total amount of goods sold during the reporting period.

For the selected cases chosen by us (Fig. 2), this computational algorithm (3) yields:

For the case a)

$$P_t = \frac{30 \times 30days - 25 \times 21days - 5 \times 20days}{30} = 9,17days \quad , \qquad (4)$$

For the case b)

$$P_t = \frac{30 \times 30days - 25 \times 29days - 5 \times 20days}{30} = 2,5days \quad . \qquad (5)$$

From expressions (4) and (5), it is evident that the proposed so-called "event-based" algorithm for calculating turnover period is correct and correlates with the estimates of the turnover period of goods depending on the speed of realization as provided above.

As mentioned earlier, this algorithm does not depend on the choice of the calculation period. It can be used for both regular goods with a constant inventory on the shelf and periodic goods that are absent from the shelf for some time. It is tied to the events of purchasing and selling goods and is not limited by the calculation period. The algorithm automatically excludes periods when goods are absent from the shelf. Since after the last sale, all funds return to circulation, there are no more components characterizing the sale of goods. The component with the "freezing" period arises only at the time of the next purchase of goods.

It is easy to see that for the presented "model" example (Figure 1), where the goods disappear from the shelf and reappear with the next purchase, this calculation is also more accurate than previously proposed algorithms.

This algorithm can be easily integrated into any enterprise accounting system since it operates only with the timing of "events," the number of purchases and sales of goods, the cost price of the goods, which are automatically recorded in the system and typically associated with expenditure and income documents. This allows obtaining calculation data on turnover for a large number of items with a single keystroke quickly

and without much effort. They do not require operator intervention in the calculation process to specify the specifics of the goods or the calculation period. When we obtain the turnover period value for each item of goods by dividing the reporting period by the turnover period, there are no difficulties in determining the turnover coefficient.

Conclusions:

- The proposed simplified algorithm for automatic turnover period calculation can be applied to both regular and periodic goods that are absent from the enterprise's inventory for a certain period during the reporting period.
- The algorithm is universal and does not require additional conditions for calculating the turnover of such periodic goods.
- The proposed algorithm is based on the fixation of time "events" of purchasing and selling goods, which determine the "freezing" of funds in goods and their return to circulation.
- This algorithm has no limitations regarding the accounting period and can be used for turnover analysis for both small (local) time intervals and longer accounting periods.
- The algorithm can be easily adapted for automatic turnover calculation in any enterprise accounting system and allows for quick data retrieval for a large number of inventory items.
- Automation of turnover calculation based on the proposed "event-based" algorithm can significantly improve the efficiency of e-commerce and greatly enhance the methodology of ABC analysis of the enterprise's inventory portfolio.

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