Classification of Goods Using the ABC–XYZ Method in a Cosmetics Wholesale Company

Problem Definition

A cosmetics wholesale company[1] is located in one of the cities of the voivodeship. It serves over one thousand stores from across the entire region. Its offer includes more than 5,500 assortment items. Apart from the large number of items, the assortment of the wholesale company is characterised by high variability. Manufacturers introduce new cosmetic lines and every two or three years make changes to the products previously offered (they change packaging, sometimes the formula or weight, and the barcode). Periodically, they also introduce promotional bundles for sale. Moreover, part of the manufacturers' offer consists of seasonal products, such as sun-care cosmetics or holiday sets.

All this makes ensuring the availability of the offer under conditions of limited working capital and warehouse space an important problem, while increasing capital or expanding the warehouse would be associated with additional costs and a reduction in profitability.

The management of the wholesale company began to analyse more thoroughly the issues related to inventory management, paying particular attention to inventory control. One of the first conclusions was the introduction of assortment classification using the ABC–XYZ method. It was recognised that such a division of the assortment would provide important information for the implementation of a number of tasks, among others, it would help eliminate shortages among the best-selling assortment items and reduce the levels of slow-moving inventory. It was also expected that it would contribute to improving the arrangement of goods in the warehouse.

The IT system used in the wholesale company did not have functionalities enabling the preparation of such a classification; however, like any modern system, it allowed data export. Therefore, it was decided that the simplest solution would be to use a spreadsheet.

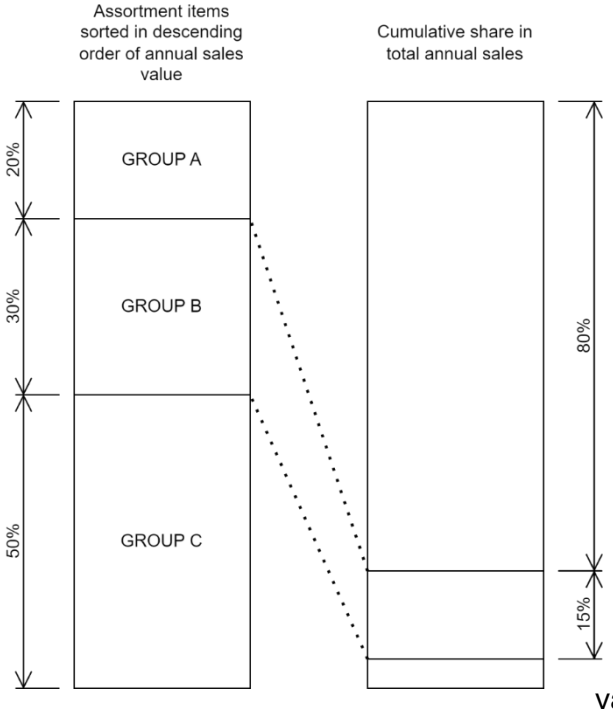
Classification Using the ABC and XYZ Method

The essence of ABC classification lies in a frequently occurring regularity consisting in the unequal distribution of the value of a given characteristic among the elements of a set, known as the Pareto principle – after Vilfredo Pareto (who, in the 19th century, on the basis of statistical analysis, discovered that 80% of Italy's wealth is owned by 20% of the population) – also referred to as the 80–20 rule.

[1] In accordance with the wishes of the owners of the wholesale company, in the presented example the company name is not provided, and the names of manufacturers and suppliers have been replaced with numbers. In addition, products in the database are identified only by indices.

The ABC method is a procedure for dividing large sets of elements into three groups according to a selected measurable characteristic of interest. In the analysed example, this will be the division of the assortment of a cosmetics wholesale company according to the annual sales value. Figure 3.1 presents a hypothetical result of such a classification. From Figure 3.1 it follows that group A constitutes 20% of all items and accounts for 80% of total annual sales, group B constitutes 30% of items corresponding to 15% of sales, whereas group C comprises half of all assortment items, whose share in total sales amounts to only 5%.

Fig. 3.1. Assortment classification using the ABC method



This means that we can obtain 95% of the sales value while holding in stock only half of the assortment: items classified into groups A and B.

Classification using the ABC method consists of carrying out the following six steps:

Step 1

We prepare the data in the form of a table consisting of two columns. The first contains identifiers of assortment items P_i, while the second contains the annual sales values w_i, where $i = 1, \dots, n$[2]. The assortment items should be ordered in descending order according to the sales value, so that the following inequality is hold:

$$w_1 \geq w_2 \geq \cdots \geq w_n$$

Step 2

We calculate the total annual sales value:

$$W = \sum_{i=1}^{n} w_i$$

Step 3

[2] In the entire description of the method, n denotes the number of assortment items.

For each assortment item, we calculate its percentage share u_i in total sales:

$$u_i = \frac{w_i}{W} \cdot 100\%$$

and the cumulative share u_{Ski}:

$$u_{cum} = \sum_{j=1}^{i} u_j$$

The calculated values of the share and cumulative share are recorded in two subsequent columns of the table.

Step 4

We determine the values of parameters α and β (e.g. 80% and 95%), which will be used to divide the assortment items into three groups A, B and C.

Step 5

In the table, we identify the assortment item P_k for which the following inequality holds:

$$u_{cum_k} \leq \alpha < u_{cum_{k+1}}$$

and the assortment item P_l for which:

$$u_{cum_l} \leq \beta < u_{cum_{l+1}}$$

and we divide the assortment into three groups, assigning to each assortment item the appropriate group symbol in the next column of the table:

$$A = \{P_1, \dots, P_k\}$$
$$B = \{P_{k+1}, \dots, P_l\}$$
$$C = \{P_{l+1}, \dots, P_n\}$$

Step 6

We prepare the result table (see Table 3.1), in which for each group we calculate:

- the number of items in the group,
- the number of items as a percentage of the total number,
- the annual sales value,
- the sales value as a percentage of the total value.

The division of assortment items according to their share in total annual sales may be a source of many important conclusions. However, it should be remembered that among the items belonging to each of the groups there may be both items whose sales in the analysed period remained at a relatively constant level, as well as those whose sales were characterised by significant irregularity. To determine this, it is necessary to supplement the ABC classification with the XYZ classification.

Classification using the XYZ method consists in dividing large sets of data into three groups according to the dynamics of changes over time of the characteristic that previously constituted the basis of the ABC classification. This implies the necessity of having data on the value of the analysed characteristic over a sequence of periods, rather than – as in the case of ABC – from only one period. In order to obtain reliable results it is recommended that the time series be as long as possible.

Table 3.1. Scheme for preparing the result table of the ABC classification

Group	Number of items	Share of number of items	Value	Share of value
A	k	$\frac{k}{n} \cdot 100\%$	$\sum_{i=1}^{k} w_i$	$\frac{\sum_{i=1}^{k} w_i}{W} \cdot 100\%$
B	$l-k$	$\frac{l-k}{n} \cdot 100\%$	$\sum_{i=k+1}^{l} w_i$	$\frac{\sum_{i=k+1}^{l} w_i}{W} \cdot 100\%$
C	$n-l$	$\frac{n-l}{n} \cdot 100\%$	$\sum_{i=l+1}^{n} w_i$	$\frac{\sum_{i=l+1}^{n} w_i}{W} \cdot 100\%$

In the literature, we can find examples in which ABC classification is prepared on the basis of data from the last month, whereas XYZ classification is based on data from the last several months, which means that in both classifications monthly data are used for calculations. As a result, the ABC analysis concerns a different period (one month) than XYZ (several months). We consider that much more valuable information is obtained when, in both classifications, data from the same period are analysed, e.g. one year. This means that for ABC classification we will use – as presented above – aggregated data, i.e. annual sales, whereas for the purposes of XYZ classification we will use data broken down into 12 months, i.e. monthly sales.

Classification using the XYZ method consists of carrying out the following six steps:

Step 1

We prepare the data in the form of a table, in which the first column contains identifiers of assortment items P_i, while the subsequent columns contain sales values in successive

periods w_{ij}, where $j = 1, \dots, m$ denotes the period number. As already mentioned, in the analysed example the XYZ classification is performed on the basis of monthly sales data, therefore the periods described in subsequent columns of the table are months, while the number of analysed periods $m$is twelve, so that it corresponds to the time span of the ABC classification.

Step 2

For each assortment item, we calculate in three subsequent columns of the table the average sales value:

$$\bar{w_i} = \frac{1}{m}\sum_{j=1}^{m} w_{ij}$$

the standard deviation:

$$s_i = \sqrt{\frac{1}{m}\sum_{j=1}^{m}(w_{ij} - \bar{w_i})^2}$$

and the coefficient of variation:

$$V_i = \frac{s_i}{\bar{w_i}} \cdot 100\%$$

It is worth recalling here why the coefficient of variation, rather than the standard deviation, is the appropriate measure for assessing the level of variability. The standard deviation allows us to measure by how much, on average, the monthly sales in the analysed period deviate from the mean. Therefore, we cannot use the standard deviation to compare items with different means, since the same value of standard deviation, e.g. 5 PLN for two items – one with an average of 100 PLN and the other with an average of 10 PLN – will indicate a completely different level of variability.

Step 3

The assortment items are ordered in ascending order according to the coefficient of variation, so that the following inequality is hold:

$$V_1 \leq V_2 \leq \cdots \leq V_n$$

Step 4

We determine the values of parameters $\alpha$and β(e.g. 50% and 90%), which will be used to divide the assortment items into three groups X, Y and Z. The determination of parameter values depends primarily on the characteristics of the analysed population. The assortment of a cosmetics wholesale company is characterised by high variability; therefore, adopting lower parameter values (in the literature we can find examples where the following values are used: $\alpha = 10–20\%$, $\beta = 30–50\%$) would result in most items being classified into group Z. It should be remembered, however, what the adoption of such high values means: assortment items with low variability (group X) are considered to be those whose monthly sales value may deviate by up to 50% from the mean.

Step 5

Since the items in the table are ordered in ascending order according to the coefficient of variation, the division into groups can be carried out analogously as in the case of ABC classification. In the table, we identify the assortment items $P_k$and $P_l$for which the following inequalities are hold:

$$V_k \leq \alpha < V_{k+1}$$
$$V_l \leq \beta < V_{l+1}$$

and we divide the assortment into three groups, assigning the group symbol in the next column of the table:

$$X = \{P_1, \dots, P_k\}$$
$$Y = \{P_{k+1}, \dots, P_l\}$$
$$Z = \{P_{l+1}, \dots, P_n\}$$

Step 6

We prepare the result table (see Table 3.2), in which for each group we calculate the number of items and the number of items as a percentage of the total number.

Finally, using both classifications, we assign each assortment item to one of nine subgroups: AX, AY, AZ, BX, BY, BZ, CX, CY, CZ, and then we prepare a summary table consisting of three rows representing groups A, B and C, and three columns corresponding to groups X, Y and Z, and in individual cells we enter the numbers of the respective subgroups.

Table 3.2. Scheme for preparing the result table of the XYZ classification

Group	Number of items	Share of number of items
X	k	$\frac{k}{n} \cdot 100\%$
Y	$l - k$	$\frac{l-k}{n} \cdot 100\%$
Z	$n - l$	$\frac{n-l}{n} \cdot 100\%$

Data description

The data required for the calculations were imported into the workbook *Classification of goods – DATA.xlsx* from the wholesale company's IT system. In the *Data1* worksheet (see Figure 3.2), there are monthly sales data for assortment items covering the period from October 2012 to September 2013.

Fig. 3.2. *Data 1 worksheet*

	A	B	C	D	E	F	G
1	MONTH	INDEX	MANUFACTURER	REMARKS	QUANTITY	VALUE	
2	2012-10	00024	Manufacturer 14		1	54,77	
3	2012-10	00027	Manufacturer 10		3	37,05	
4	2012-10	00053	Manufacturer 16		3	34,64	
5	2012-10	00054	Manufacturer 16		1	15,26	
6	2012-10	00055	Manufacturer 16		1	7,13	
37762	2013-09	15355	Manufacturer 55		1	4,13	
37763	2013-09	15393	Manufacturer 24		8	77,87	
37764	2013-09	15395	Manufacturer 24		23	280,28	
37765	2013-09	15404	Manufacturer 60	P	4	5855,74	
37766	2013-09	15476	Manufacturer 51		32	22,4	
37767							

In the subsequent columns of the table there are:

- the month to which the record relates,
- the index of the assortment item,
- the manufacturer or supplier of a given item,
- remarks regarding the seasonality of the item (this column may contain one of three designations: **P** – promotional/holiday bundle, **O** – sun-care cosmetics, and **O,P** – promotional bundle of sun-care cosmetics),

- the number of units sold in a given month,
- the net value of monthly sales.

The data are ordered in ascending order by the month of sale and the index of the assortment item. A single row of the table indicates that in a given month a sale or a return of a given assortment item took place.

Tasks for Independent Completion

Task 1

What should the values of parameters $\alpha$and βin the ABC classification be so that the share of the number of items in individual groups is as follows: A – 20%, B – 30%, C – 50%?

Write the answer in the **Results** worksheet next to the table containing the classification parameters.

Task 2

In the **Results** worksheet, create a table analogous to **Summary of ABC and XYZ Classification**, presenting the number of items in individual subgroups as a percentage of all assortment items.

Task 3

In the **Results** worksheet, create a table analogous to **Summary of ABC and XYZ Classification**, presenting the annual sales value of each subgroup.

Task 4

Present the results from the **Summary of ABC and XYZ Classification** table in the form of a **stacked column chart**, in which the columns represent categories A, B and C, and each column is divided by colours into categories X, Y and Z.

Insert the chart into the **Results** worksheet and give it the same title as the source table.

Task 5

In a new worksheet named **Z5**, prepare a summary presenting the sales of sun-care cosmetics in successive months of the analysed period.

In which month were sales the highest?