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Justyna Bobowska, Natalia Szozda
Wrocław University of Economics

DEMAND AND SALES ANALYSIS FOR A SHORT LIFE CYCLE PRODUCT

1. Introduction

Identifying demand with sales data is a common practice in many companies. It is both easy and convenient. Thanks to cash registers sales data recording became very easy even in small retailer points of sale. The data of sales are often used as input data for forecasting and decision-making purposes. But if we define demand as a customer expressed need for a certain article, at a certain price, at a certain time and at a certain place, combined with the willingness and possibility of purchase [3] and sales as the met and fulfilled demand, we can see that demand should be understood much wider. Demand is an independent variable and sales is a value dependent on demand and two other aspects: possibilities of company production force and logistic system of inventory and replenishment.

In the article, basing on short life cycle product analysis, the authors want to focus on this other aspect which is omitted quite often – inventory and order system. Main goals of the research are:

- examining the influence of applied inventory systems on sales curve shape,
- searching for the system giving better results in sales curve to demand curve fitting.

Applying a simulation model the authors managed to present two variants of implementing classic inventory systems. The simulation was performed on an example of short life cycle product. In first approach the scenario was considered in which parameters level were adjusted to the realistic constraints. In the other approach the attention was put on finding the level of parameters that maximize sales in each period, so that both: demand and sales curves are identical in the whole life cycle. The results of examinations are compared in respect of lost benefits and overall costs.

2. Short life cycle product

Common definition of product life cycle is determined as the whole period of time since the moment of introducing an article at a certain market till the moment of withdrawal. We can say that a certain product has a short life cycle when the whole period of sales at a market is no longer than two years. We can observe that products – their models and versions change more and more quickly. The phenomenon is specially intensive in some branches connected with electronics like: computer science; telecommunication etc. Commonly quoted causes of shortening product life cycle are:

- strong competition that pushes firms to fight for a client with a new innovative product,
- increasing customers' needs to have things better more functional and unfailing,
- life style change – people live more intensive and things go out of fashion quickly.

The factor that enables the whole process of shortening product life cycle is possibility of free material, people and information flow within modern economics and politics structures e.g. within European Union. It is also obvious that without technological progress and information exchange nothing could happen. All the things together causes that more and more products characterize with the short life cycle. That's why the authors decided to take into analysis this kind of product. The simulation was made for a mobile phone. Figure 1 shows the graph.

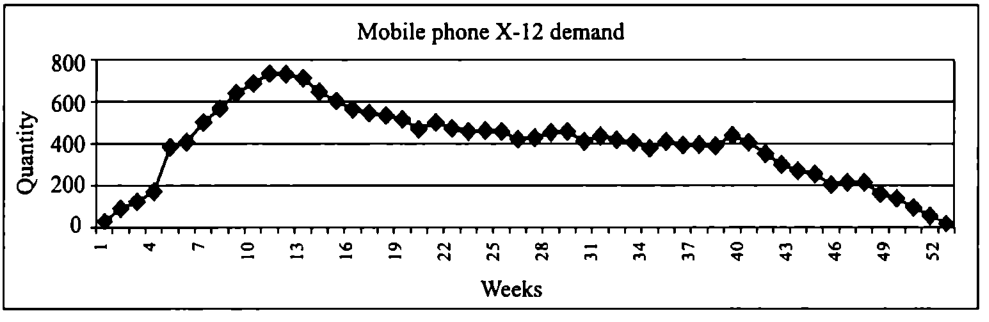

Fig. 1. Product life cycle

Source: own study based on [1].

In the picture we can see a very characteristic shape of product demand in the whole life cycle. First we can observe a rapid increase in demand, than the maturity phase in which we observe relative stability and in the end a final phase that characterizes with a decrease in demand. All the movements in demand take place in a period of one year, so that annual variability of the product is very high.

3. Building a model

To fulfill the aims of the research a simulation model has been established. The model bases on really existing networks distribute their services by their points of sale all over the country (Poland). The information about the networks and the sales has been gathered through the internet, particular network's offers and in interviews with salespeople.

Thanks to the information the authors managed to create the demand data needed to the simulation. Main premises to demand curve constructing were as follows:

- known length of the mobile phone X-12 life cycle,
- known values of average sales observations,
- known marketing activities of particular networks,
- the authors has had an access to the information about estimated maximum and average value of demand in some POS.

3.1. Distribution

In the model the mobile phone X-12 is sold by 65 points of sale (POS) that operate within three basic GSM networks:

- Network I that possess 32 POS,
- Network P that possess 17 POS,
- Network E that possess 16 POS.

The telephone can be sold only in a packet with a subscription service purchased in a GSM network. All the networks sell their services through the POS.

Network I is the biggest one and has a position of lieder in the market. The product – mobile phone is introduced to the market with the first week of January. In March and April the network introduced new attractive subscription service that was sold in a packet only with some mobile phones (including X-12). It resulted with a rapid increase in analyzed product demand. In summer (July and August) network I organized special promotion of the whole service packet.

Network P introduces the product with the first week of February. In these first periods, in all POS a big promotion takes place. The promotion is connected with a new product and aims to take some clients from I network.

Network E, which introduces the product with the same period – first week of February does not undertake any kind of promotion action at the beginning of the product life cycle, focusing the efforts on different models of mobile phone that are – in their opinion – more attractive.

All networks withdraw the phone with the end of a year. Network I gives up the product's sales in November and network P and E – in December. It means the end of product life cycle, but before the withdrawals, from second half of September all the companies sell the product in a special offer – 1 zł + VAT.

3.2. Model assumptions

Each POS gathers following data each period:

- week number – which is a time unit,
- customer demand – which is an expressed willingness and readiness to purchase,
- initial inventory level – which is a result of final inventory level from last period,
- sales – which is a result of the demand met in a certain period and initial inventory level thus:
  - if inventory level is bigger or equal the customer demand – sales is equal the customer demand,
  - if inventory level is smaller than the customer demand – sales is equal the initial inventory level;
- inventory replenishment – which is the order placed at a certain network one period ago,
- final inventory level – which is a difference between an initial inventory level and
- order put in a particular network – which is a result of applied inventory system,
- lost benefits – an amount of goods that could be potentially sold (because of customer demand) and weren't because of stock shortage.

As we can see, one basic assumption was made in a model: the only possibility of sales being lesser than the demand in period t is when a POS hasn't got sufficient inventory level in period t.

Inventory systems

The authors applied two classic inventory system:

- the system of constant order cycle and variable order quantity – (T, S); where T is an order cycle length measured in period units, and S is an order-up-to point measured in stock keeping units,
- the system of variable order cycle and variable order quantity – (s, S); where s is a certain inventory level setting the time of order placement, and S is described above.

In both systems quantity of order is described as $Q = S - \textit{Inventory level}$, but in one system an downstream stage places an order regularly – in the other, an order is placed variably. The system of variable order cycle and constant order quantity (s, Q) was not applied because the demand assumptions were not met.

Parameters construction

The parameters used for implementation particular inventory systems were defined as:

- Parameter $S = \overline{d_{ij}} \cdot (1 + V_j \cdot \alpha_j)$ [compare 4],
- Parameter $s = \overline{d_{ij}} \cdot \beta_j$ [compare 4],
- Period T = multiple of a week,

Where: d_{ij} – average demand met in a certain POS i operating within a network j,
V_j – variability coefficient for a certain network j,
α_j – the coefficient for parameter s for a certain network j,
β_j – the coefficient for parameter S for a certain network j.

The coefficients α_j and β_j that were taken into the parameters s and S construction, give a possibility to manipulate the values of these parameters among the network, but in the same time leave individually suited for each POS form of them.

Cost ingredients construction

In the simulation three components of cost were considered:

Unit ordering cost:

- If a POS in a certain week puts an order in the upstream stage (network) has to bear unit ordering cost = C_o;
- if not – he doesn't bear any costs.

Inventory cost: $C_l = (r_{ij} \cdot u_s)/O_j$ [compare 4]

Holding cost: $C_h = (p_{jj} \cdot i_j) \cdot \frac{I_{pi} + I_{ki}}{2}$ [compare 4]

Where: p_j – product price for a certain network j,
h_j – holding rate for a certain network j,
r_{ij} – weekly rent cost for a certain POS i,
u_s – trade surface assigned for inventory (in percentage terms),
I_{pi} – initial inventory level for a certain POS i,
I_{ki} – final inventory level for a certain POS i,
O_j – quantity of mobile phones that a certain network j sells through their POS.

All cost components were counted periodically (weekly). Overall cost was determined as a simple sum of all components.

4. Approach based on realistic constraints

In first approach the authors intended to check the efficiency of classic inventory systems in case of realistic constraints. From the inquiries the authors ascertained that among the POS operating within really existing networks (Idea, Plus and Era) – regular order cycle system is mostly used, and the period T is fixed as 1 period (week). Knowing that total trade surface assigned for inventory cannot exceed in average 15% of trade surface, and assuming that each POS must have an opportunity to fulfill the met demand – the values of parameters were as follows:

- Period T = orders placed every 1 week,
- Parameter $S = \overline{d_{ij}} \cdot \beta_j$; (coefficient $\beta_j = 2{,}5$) [compare 4].

From the equations above we can see that parameter S – the order-up-to point is determined as double and a half average demand met in a certain POS i operating within a network j. It is the highest value possible because of the inventory capacity. The simulation gave the results showed in Table 1.

Table 1. (*T*, *S*) inventory system

Network	Parameters		Lost benefits	
	T	*S*	weekly	per year
I	1	17,4	-84,3	-4386
P	1	15,7	-39,6	-2064
E	1	13,2	-29,0	-1508

Source: own study based on [4].

Figure 2 shows the differences between the demand and sales curves.

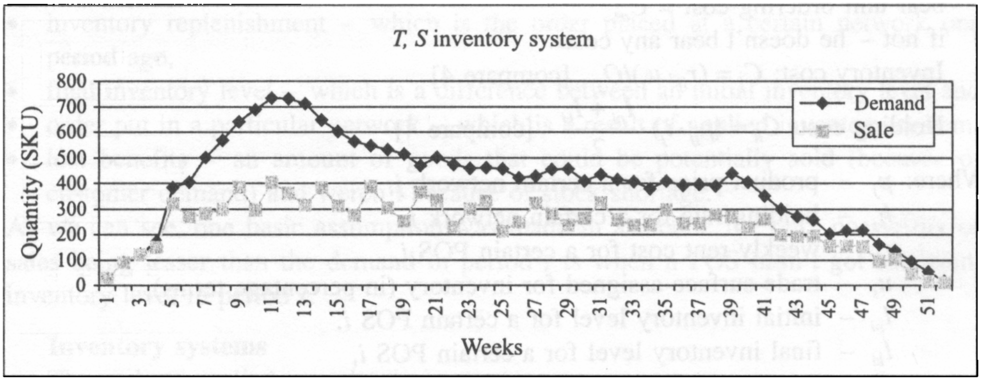

Fig. 2. Demand and sales of mobile phone X-12 within three networks
Source: own study.

In the next simulation (s, S) inventory system was applied which means that the order cycle is not fixed but it depends on parameter s. The value of both parameters were described as:

- Parameter $s = \overline{d_{ij}} \cdot (1 + V_j \cdot \alpha_j)$; (coefficient $\alpha_j = 1$) [compare 4],
- Parameter $S = \overline{d_{ij}} \cdot \beta_j$; (coefficient $\beta_j = 2{,}5$) [compare 4].

As we can see, parameter S remains unchanged and parameter s is determined also as average demand met in a certain POS i, enlarged with the percentage of this value depending on the variability coefficient. Table 2 shows the simulation results.

The analysis showed that the applied inventory models do not provide sufficient inventory level that allows for fulfilling demand in 100%.The differences between the demand and sales curves are particularly visible in the faze of active demand. (T, S) model gives:

- 64% demand fulfillment per week which means that weekly 153 mobile phones are not sold because of stock shortage.

Table 2. (*s*, *S*) inventory system

Network	Parameters		Lost benefits	
	s	*S*	weekly	per year
I	9,8	17,4	-49,2	-2560
P	8,3	15,7	-24,2	-1256
E	6,6	13,2	-19,4	-1009

Source: own study based on [4].

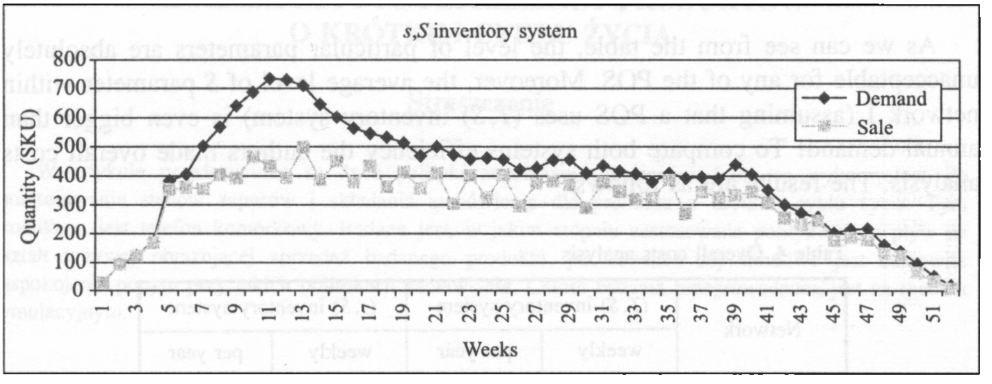

Fig. 3. Demand and sales of mobile phone X-12 within three networks

Source: own study.

In s, S model the situation is better, but also far from ideal. Given results are:

- 78,7% demand fulfillment per week which means that weekly 93 mobile phones are not sold because of stock shortage.

Figure 3 shows the differences between the demand and sales curves.

5. Sales maximizing

In the other approach the attention was put on finding the level of parameters that maximize the sales, thus both curves are identical. In the procedure of finding an optimal solution the following parameter levels were indicated:

Table 3. Parameters and coefficient values for sales maximizing criterion

	(T, S) inventory system			(s, S) inventory system				Demand	
	coefficient	parameters		coefficients		parameters			
Network	β	T	S	α	β	s	S	weekly	per year
I	52	optional	352	5	25	22	169	6,8	344,3
P	31	15	190	6	20	19	123	6,1	311,4
E	31	17	165	9	24	19	123	5,1	260,3

Source: own study based on [4].

As we can see from the table, the level of particular parameters are absolutely unacceptable for any of the POS. Moreover, the average level of S parameter within network I (assuming that a POS uses (T, S) inventory system) is even bigger than annual demand! To compare both systems efficiency the authors made overall costs analysis. The results are as follows:

Table 4. Overall costs analysis

Network	(T, S) inventory system		(s, S) inventory system	
	weekly	per year	weekly	per year
I	13 396	664 635	9 797	494 060
P	9 074	471 859	5 147	267 635
E	8 327	432 980	7 391	384 354

Source: own study based on [4].

6. Conclusion

Table 4 shows overall costs for both inventory system applied. In case of each network (s, S) system gives lower costs assuming no lost benefit. The results suggest that short life cycled product should be run with the inventory system based on variable order cycle better than constant T-period. Although (s, S) inventory system gives better effects, the simulations showed that both systems do not cope well in the circumstances of short life cycle product. Ideal fit of demand and sales curves is only possible when rising the level of parameters to the unacceptable value. It means that continuous research on new, better solution is necessary.

References

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ANALIZA POPYTU I SPRZEDAŻY PRODUKTÓW O KRÓTKIM CYKLU ŻYCIA

Streszczenie

W artykule przedstawione są dwie polityki zamawiania surowców, które są wykorzystane do monitorowania stanów zapasów i składania zamówienia dla produktu o krótkim cyklu życia. Tym produktem jest telefon komórkowy. Badane jest, w jakim stopniu zastosowana polityka ma wpływ na kształt krzywej obrazującej sprzedaż badanego produktu, jak również czy możliwe jest całkowite zaspokojenie popytu przy takich politykach zamawiania. Całość badania przeprowadzona jest na modelu symulacyjnym.