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Mariusz Kmiecik

Silesian University of Technology
Faculty of Organization and Management
Institute of Management, Administration and Logistics
mariusz.kmiecik@polsl.pl

USAGE ATTEMPT OF FORECASTING METHOD IN A SELECTED ENTITY WITH CONSIDERATIONS ABOUT THE NECESSITY OF CPFR IMPLEMENTATION

Summary: Main factor, which has got influence on aspects, activity, configuration, and efficiency of mentioned supply chain is demand's fluctuations. The ability to predict fluctuations is the basis of creating the competitive advantage and increasing the customer service level. The purpose of following paper is to demonstrate the necessity of using a quantitative forecasting methods and to show further research directions connected with CPFR implementation in selected entity. The main issue of demand management consideration has a CPFR conception. One of the many advantages of CPFR is the improvement in forecast accuracy, eg. accuracy of exponential smoothing forecasting methods like Winter's method, by gaining ability to make proper modifications of this method based on reached demand information. Second part of this article is based on case study concerns on one of the basic exponential smoothing forecast method in comparison with current forecast method and necessity of CPFR implementation in the future.

Keywords: CPFR, demand management, forecasting, Winter's method.

JEL Classification: L20, M10.

Introduction

Effective delivery of products and services is the main goal of cooperation in a supply chain. Initially, enterprises did not have a strong need to strengthen and develop cooperation forms with their contractors. Consequently, their relations were limited only to simple transactions. Nowadays, enterprises in supply chains are striving to achieve close integration in order to meet the final customer's needs. Growing customer's expectations imply the need of supply chain's reconfiguration of the results is aflexible and dynamic system which allows for efficient flow of material and information.

Demand fluctuations are one of the factors which influencing the shape of a supply chain. Ability to react to these fluctuations is one of the foundations of creating a competitiveness advantage. To keep the ability to this reaction, enterprises are creating selling forecasts. Forecasts are creating processes and operations connected with decision problems, such as: quantity of ordering, producing or transporting products. Forecasts could improve planning in all areas of logistics. Therefore, forecasting is one of the key problems, which requires analysis in the context of modern enterprises. The need for forecasting is a sequence of two things: uncertainty of the future and delays between the moments of decisions taking and the consequences of these decisions. Showing proper forecasting method is time-consuming and a lengthy, multistage process. However, using proper forecasting methods could have positive influence on increasing the customer service level and efficiency of all nodes in supply chain.

One of the strategies, which is based on forecasting and cooperation in supply chain, is Collaborative Planning, Forecasting and Replenishment (CPFR). The aim of the article is a demonstration of necessity of using a quantitative forecasting methods and showing the further research directions connected with CPFR implementation in selected entity. Generally, cooperation in CPFR conception concerns the exchange of demand information. Thanks to fast information exchange, enterprises should improve their reaction to demand fluctuations and even have some influence on it. Article focuses on showing possibilities of forecasting method, the use of which is based on exponential smoothing and time series. In the next step, the prospect for development is shown – proposed prospect is the CPFR implementation.

1. Demand management

1.1. Demand management – concept development

Supply chains adjust to the kind of a demand, customers' requirements and to the competitive advantage requirements by formation of their structures [Kmiecik, 2017]. It is important to having the right products on the shelves, because it increase sales and customer loyalty [Zinn, Liu, 2001]. Configuration involves elements such as: selection of supplies, transportation and modes of pro-

cesses in all stages of a supply chain [Nepal, Monplaisir, Famuyiwa, 2010]. Methodology of configuration consists of the following stages [Kawa, 2009]:
– enterprises network mapping,
– process rationalization,
– designing and building IT architecture,
– identification of costs and flows time in enterprises' network,
– supply chain partners' selection.

Supply chain's configuration used to be a one-shot problem, but a single configuration has never been optimal or efficient. Ideally, supply chains should not be static – they should be dynamic, able to change their configuration, according to the environment [Emerson, Piramuthu, 2004]. Accepted configuration should depend on elements such as [Sołtysik, Świerczek, 2009]: goals of supply chains, subject of goods flow, goals and ranges of supply chains participant's tasks, ranges of supply chain's activities and kinds of connections between entities in supply chains. Main aims of configurations are: reduction of logistics cost, improvement of customer service level and chain participants profit [Gołębiewska (red.), 2010]. During the implementation of these goals, a number of problems may arise. Problems occurring in supply chain configuration are shown in Table 1.

Table 1. Classification of selected configuration problems

Group of problems	Problem	Specify
Specific	network design	facility locations
		allocation
	forecasting	long-term forecast
		short-term forecast
	logistics	inventory management
		transportation
		warehousing
General	flexibility	volume flexibility
		process flexibility
	collaboration	collaborative design
		collaborative planning

Source: Based on: Chandra, Grabis [2007].

Demand planning, like forecasting, also affects configuration decisions [Szozda, Świerczek, 2016]. Making decisions takes place after providing data about demand and forecasting algorithms and there are also no specific forecasting components without proper configuration.

Main features of demand on flowing goods are [Chandra, Grabis, 2007]:
- size of orders – it is average quantity of order,
- demand predictability – defines the error in forecasting,
- demand variability – it is the relation between demand pattern and average demand,
- market size – it is a rate of penetration for the specific products categories,
- domestic market strength – in comparison to global demand of a company.

Proper types of supply chain should be created for adjusting supply chains to a particular kind of demand of flowing goods. Table 2 illustrates 4 types of basic supply chains taking into consideration: demand, products, and organizational activities.

Table 2. Types of supply chains dependent on demand

Type of supply chain	Demand kind	Products type	Supply process type	Goals of supply chain
Efficient supply chain	landline demand	functional products	stable process	the main goal of this chains is creating the highest cost efficiencies
Risk hedging supply chain	cyclical stationary demand	functional products	evolving process	pooling and sharing resources and eliminating the disruptions
Responsive supply chain	cyclical non-stationary demand	innovative products	stable process	being responsive and flexible to variable customer needs
Agile supply chain	extremely unstable demand	innovative products	evolving process	being flexible and responsive to customers requirements, while the risks of supply shortages or disruptions are hedged

Source: Based on: Lee [2002]; Szozda, Świerczek [2016].

When comparing functional and innovative products, from the perspective of demand characteristic, innovative products have more unpredictable demand, which is difficult to forecast. There is also short selling season and high inventory cost and profit margins. Functional products have lower: stockout cost, obsolescence, and demand uncertainties [Lee, 2002]. In stable supply processes, the production processes and underlying technologies are mature. In evolving supply process the manufacturing processes and underlying technologies are still developing and changing rapidly [Raz, 2009]. Data connected with demand are required to other supply chain activities [Chandra, Grabis, 2007], but the information on its own is not enough – enterprises in supply chains should make demand plans to make supply chain operations more effective. Demand management focuses on information management which allows demand forecasting and fulfilling the plans [Ciesielski (red.), 2009]. It requires from participants adjusting the organizational structure, processes, resources, and infrastructure [Baraniecka, 2004]. The process of demand management is not limited only to forecasting. It includes also synchronizing demand and supply, reducing variability and increasing flexibility [Croxton et al., 2002]. However, properly implemented demand management allows: preparing and disseminating of strategic plans, satisfy the customers needs, creating of value added, and organization of efficient goods and information flow [Ciesielski (red.), 2009]. Demand management conception has evolved over time. The stages of development are shown in Table 3.

Table 3. Demand management conceptions development

Stage	Characteristic
1. Product's demand projection	More careful than forecasts. In product's demand projection there are some assumptions and scenarios which often are completely different than real demand level. There are no forecasts
2. Product's demand forecasting	It assumes that prediction of future demand level will be relatively reliable, despite the forecasting error. Error, in further considerations, is evaluated and forecast is updated. The subjects of forecasting are marketing and sales only
3. Sharing data in plans of product's demand	It is designed to facilitate the information flow. Information concerns the level of present and future demand
4. Making demand plans inclusive supply and demand streams	Coordination of supply and demand streams determine a high level of customer service. Demand and supply plan is synchronized through integrated management processes. It is a connection between reaching a high level of efficiency and flexible reaction for customer needs. Synchronization is on logistic processes only
5. Demand collaboration with supply chain partners	It is based on effective demand planning and integration between functional planning and forecasting. Two stages before (3rd and 4th) are the necessary condition to implement 5th stage. It includes wider range of demand and supply streams synchronization, not only in logistic processes

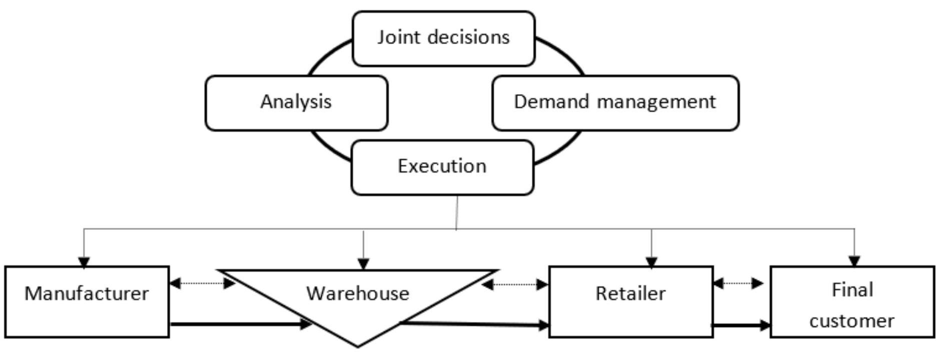
Source: Based on: Anderson, Carroll [2007]; Szozda, Świerczek [2016]; Lau [s.a.].

The main barriers for demand planning are: insufficient attention which is given to statistical modeling of historical demand's levels – forecasting should go out beside time series, it could also include elements as knowledge of market and customers behavior should be taking to consideration [Vlckova, Patak, 2011]. There are a lot of methods and tools helping to handle with these and others barriers. These tools are, e.g.: Electronic Data Interchange (EDI), Automation Identity (AI), Database Management, Electronic Founds Transfer (EFT), Activity Based Costing (ABC) and, which dominates in technologies and techniques in process integration, Collaborative Planning and Forecasting Replenishment (CPFR) [Ciesielski (red.), 2009]. CPFR, due to its high importance, is presented in more detail in further considerations.

1.2. Collaborative Planning and Forecasting Replenishment (CPFR)

CPFR based on Vendor Management Inventory (VMI) concepcion [Ciesielski (red.), 2009] and it is defined as: "formalized process between two trading partners used to agree upon a joint plan and forecast, monitor success through replenishment, and recognize and respond to any exceptions" [Kazemi, Zhang, 2013]. The advantage of CPFR over VMI is to eliminate uncertainty by improving communication and collaboration among supply chain's participants. The CPFR system is illustrated in Figure 1.

Figure 1. CPFR system



Source: Kazemi, Zhang [2013, p. 552].

The demand is registered at the point of sale and transmitted to other partners which are responsible for planning. One of the most important issue in CPFR is clearance of transmitted data [Saha, 2005]. The retailer and manufacturer are sharing authority over the entire system. All nodes are making joint decisions about managing the whole system (includes: production, processes, and distribution). There is no limit about information transfer in supply chain and demand information is directly transmitted to the whole chain. CPFR gives great opportunity for both, suppliers and customers, to be involved in demand forecasting and replenishment of inventory [Kamalapur, Lyth, Houshyar, 2013]. CPFR focuses on 9 steps [Min, Yu, 2004]:

1. Develop front-end agreement.
2. Create joint business plan.
3. Create sales forecasts.
4. Identify expectations for sales forecast.
5. Collaborative on exception items.
6. Create order forecast.
7. Identify exceptions for orders forecasts.
8. Collaborate on exception items.
9. Order generation.

Steps of CPFR includes 3 main groups: planning (steps 1-2), forecasting (steps 3-8), and supplies replenishment (step 9) [Szozda, Świerczek, 2016]. Benefits of CPFR include: lower stock-out rate, higher inventory turnover, improved cash flow, reducing order costs and faster response to customer requirements [Min, Yu, 2004]. The main element of mentioned demand management and CPFR is forecasting. There are 3 basic forecasting methods: subjective forecasting, cause-effects forecasting, and time series forecasting [Murphy, Wood, 2011]. One of the methods, which is used for forecasting future quantity of time series, is Winter's method.

1.3. Winter's forecasting method

Winter's method (in literature also called Holt-Winters method [e.g. Lattyak, Stokes, 2011; Zagdański, Suchwałko, 2016] is exponential smoothing forecasting method based on time series. The algorithm of the method consists of 3 parts: general smoothing, trend smoothing, and periodicity indicator smoothing [Bielińska, 2007]. It is applied to forecasting products which demands are characterized by trend and periodicity. Initialization of the procedure focuses on estimation about one full period, which is necessary for further consideration. There are differences between forecasting algorithm for these 2 options. The difference in calculation is presented in Table 4.

Table 4. Forecasting algorithms

	Additive	Multiplicative
a_t	$\alpha(Y_t - s_{t-p}) + (1-\alpha)(a_{t-1} + b_{t-1})$	$\alpha \frac{Y_t}{s_{t-p}} + (1-\alpha)(a_{t-1} + b_{t-1})$
b_t	$\beta(a_t - a_{t-1}) + (1-\beta)b_{t-1}$	$\beta(a_t - a_{t-1}) + (1-\beta)b_{t-1}$
s_t	$\gamma(Y_t - a_t) + (1-\gamma)s_{t-p}$	$\gamma \frac{Y_t}{a_t} + (1-\gamma)s_{t-p}$
$\hat{y}_{T+t}$	$a_T + tb_T + s_T$	$(a_T + tb_T) * s_T$
Starting values		
a_p	$\frac{1}{p}(Y_1 + Y_2 + \cdots + Y_p)$	$\frac{1}{p}(Y_1 + Y_2 + \cdots + Y_p)$
b_p	$\frac{1}{p}\left(\frac{Y_{p+1} - Y_1}{p} + \frac{Y_{p+2} - Y_2}{p} + \cdots + \frac{Y_{p+p} - Y_p}{p}\right)$	$\frac{1}{p}\left(\frac{Y_{p+1} - Y_1}{p} + \frac{Y_{p+2} - Y_2}{p} + \cdots + \frac{Y_{p+p} - Y_p}{p}\right)$
$s_1 = Y_1 - a_p, s_2 = Y_2 - a_p, \ldots, s_p = Y_p - a_p$		$s_1 = \frac{Y_1}{a_p}, s_2 = \frac{Y_2}{a_p}, \ldots, s_p = \frac{Y_p}{a_p}$

Source: Based on: Tirkes, Guray, Celebi [2017, pp. 504-506].

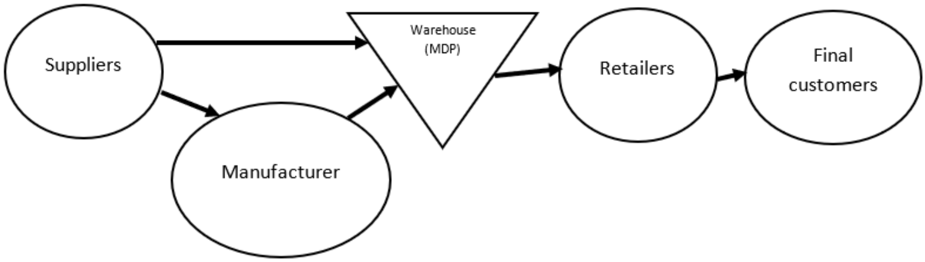
Next point of article focuses on case study. Case study begins with description of current situation.

2. Case study

2.1. Current state

The subject of research is the warehouse which belongs to a ceramic products manufacturer. The entire assortment of products in the enterprise consists of 330 products. The main assortment group are the ceramic tiles – about 150 products. So, chosen assortment group is 46,53% of all products. The supply chain configuration from the perspective of the chosen products is shown in Figure 2.

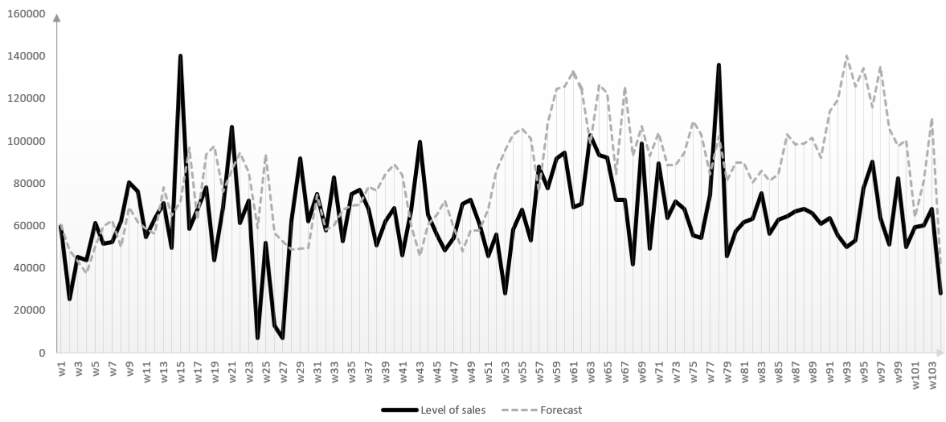
Figure 2. Supply chain of chosen assortment group



There are 2 kinds of suppliers – the first, which supplies the necessary materials for production, and the second, which produces and supplies the product with company's logo. The second group consist of 9 suppliers. Manufacturer, to be flexible to customers' needs, produces goods, according to Make to Stock (MTS) system. In present supply chain configuration, enterprise prefers to create a high inventory level instead of taking a risk of lack of sales. Warehouse is a Material Decoupling Point (MDP), which has a function of safety buffer between the supply and demand streams. From the warehouse, products are distributed to about 640 retailers and further, in the next step, to final customers.

Currently enterprise does not have clearly marked demand management system. Information transfer between particular nodes is not effective. Information from other nodes is transferring only in extraordinary situations. Forecasts are usually made with high level of tolerance to unexpected customers' activity and as an effect, creating a lot of stocks. This situation is visible in the second part of the considered periods (Figure 3).

Figure 3. Considered periods – level of sales and forecasts



One period consists of one week of sales, there is 104 periods, so there is a time series based on 2 years of sales. First step of research focuses on proposing a proper method of forecasting, which accuracy will be higher than current method and in the next step the idea of improving forecasts by CPFR and demand management system is presented.

2.2. Prediction by exponential smoothing

To find the best option of forecast algorithms, which are based on time series and which could be proper for sales character (Figure 3), 8 different algorithms were considered. Each of the algorithms depends on trend and seasonality kinds. The main determinant of the choice of method was the Mean Absolute Percentage Error (MAPE). MAPE is shown in Table 5 and concern on ex-post errors for forecasted 104 periods. Each period contains one week of the selected sales quantity of the assortment group.

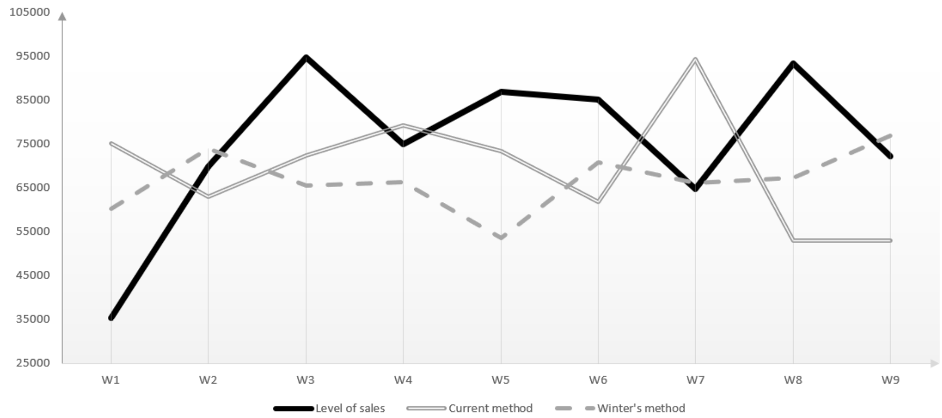
Table 5. MAPE for analyzed causes

Characteristic of:		**MAPE**
Trend	**Seasonality**	
non	multiplicative	38,95%
non	additive	38,77%
linear	multiplicative	37,59%
linear	**additive**	**36,34%**
exponential	multiplicative	38,04%
exponential	additive	38,54%
damped	multiplicative	38,04%
damped	additive	38,54%

The smallest ex-post error occurs in case of using exponential smoothing method based on linear trend and additive seasonality, i.e. by using Winter's method in additive seasonality version. In the same way, MAPE indicator, was calculated to real quantities of supplies in this periods which are the reflection of forecasts made by subject of research. The MAPE indicator for enterprise forecast in this same periods was on the level of 60,20%. Enterprise made forecast majority based on quality methods; often the forecasts were overstated, because of frequent, unexpected increasing orders. These activities led to the creation of a high level of supplies in the warehouse. In 2016 the difference between in and out goods was about 500 000 Stock Keeping Units (SKU's), and in 2017, because of market expansion and unexpected customers reactions, it increased to about 1 800 000 SKU's. This is a very alarming trend.

The proposed forecasting method was also tested in 9 further periods in 2018. It also gave better results in MAPE indicator comparison – for the current method it was 34,49% and for Winter's method it was 23,37%. The comparison with the real level of sales is presented in Figure 4.

Figure 4. Comparison of level of sales and current and Winter's method forecasts

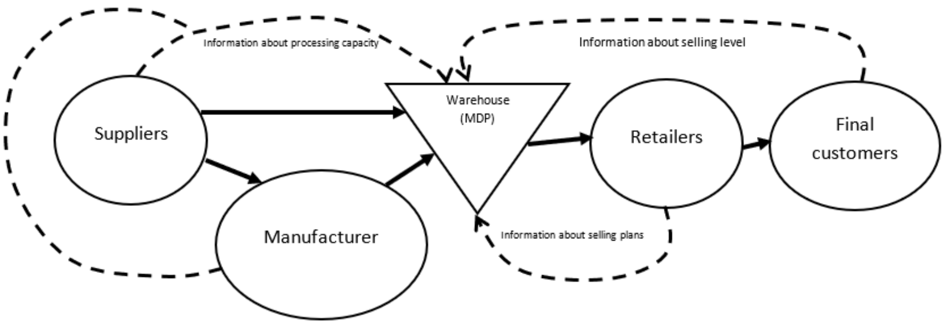


Using Winter's method without modifications could cause a lack of stock to sales in the beginning of forecasts' period. To get better forecast and more flexibility to customer needs, it is suggested to examine other forecasting methods, like, e.g., ARIMA. The second idea is to implement the CPFR concept in throughout the entire supply chain in the future. This can improve forecast accuracy and improve the demand management system.

2.3. Directions to improve demand management system – possibility of CPFR usage

To ensure the highest level of forecasts accuracy and reduce level of stocks, it is proposed to implement actions based on CPFR conception. CPFR should consist of cooperation between all nodes in the chain. First stage of implementation should focus on finding some solution and common goal between: suppliers, manufacturer, and customer development. It should include processing capacity of production and transportation of suppliers and manufacturer and next, compare it with customers' requests. It should allow to prevent the unexpected pick in sales (like in 15th and 77th periods). After collaboration arrangement and business plan elaboration it should be a forecasting improvement.

Figure 5. General information flow in the proposed solution



Forecasting in CPFR should be based on the exchange of information. The forecast should not be based only on selling history, but also on information directly from selling points (i.e. from the point of selling belonging to retailers or from the retailers' customers). Next, the forecast should be updated by current information from all of the supply chain's participants. The general idea of sales and demand information flow is shown in Figure 5.

The node responsible for preparing the plan may be the warehouse which belongs to the manufacturer. Based on obtained information about demand, stocks levels in nodes, time of orders fulfillments and information about processing capacity, warehouse should be able to create order schedules. Orders schedules will consist of requirements of orders and products. After orders, the planner should be responsible for stock replenishment in all nodes in their distribution channel and continuous forecasts, information and activity updating. The benefits and barriers for CPFR implementation that may occur are listed below (Table 6).

Table 6. The benefits and barriers of CPFR implementation

Benefits	Barriers
• Increasing the forecasts accuracy • Reducing the stocks • Improving flexibility to demand's changes • Decreasing the *bullwhip effect* in supply chain • Reducing demand fluctuations • Increasing the safety of supplies • Highest level of cooperation in supply chain • Clarity of customer needs and their stocks level • Customer service level optimization	• Necessity of confidential information transfers • Necessity of hiring additional resources • High investment and resource involvement in all stages of supply chain • Increasing in dependence on selected suppliers

Comparison of benefits and barriers gives a view on the problem with implementing CPFR. This field is an interesting area of further researches based on possibility of CPFR implementation.

To implement the right demand management model in the future, enterprise should choose appropriate forecasting method and improve information transfers between other nodes in the supply chain, and as a effect of that implement a CPFR. It will allow to create a base to demand planning, and in the next steps create a proper demand management system.

Conclusions

Literature review showed the importance of demand management in contemporary supply chains as well as the relevance of CPFR conception. Research indicates the advantage of the proposed forecasting method over the current one. The ex-post errors for considered 104 periods are smaller than in current method. The same situation is for the next 9 periods, when the accuracy of proposed method (with established parameters) was still higher. The smallest MAPE concerned the algorithm of linear trend and additive seasonality – for the Winter's method in additive seasonality version. However, for better forecasting and for using the method with higher accuracy, it is proposed to implement a CPFR in the whole supply chain. Implementation of this conception will be based on improving the demand information exchange and transmitting this information directly from the point of sales to the planner's enterprise. It is assumed that considered enterprise, by his Material Decoupling Point character, could be such that a planner who will be able to demand planning and forecasting to the whole supply chain. Benefits of CPFR implementation are significant, despite difficulty and complications of initiating and implementing activities. Properly implemented conception should ensure a forecast accuracy improvement, reduce stocks and improve the final customer service. The purpose of article was fulfilled. Proposed quantity method of forecasting was better than current quality method and also the meaning of CPFR implementation was shown. Contemplated solution is an interesting area for further consideration and research.

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PRÓBA UŻYCIA METODY PROGNOZOWANIA W WYBRANYM PODMIOCIE Z ROZWAŻANIAMI NA TEMAT KONIECZNOŚCI WDROŻENIA CPFR

Streszczenie: Kluczowym czynnikiem, który ma wpływ na aspekty, funkcjonowanie, konfigurację oraz skuteczność łańcuchów dostaw, są wahania popytu. Zdolność przewidywania wahań jest podstawą do kreowania przewagi konkurencyjnej i podniesienia poziomu obsługi klienta. Aby zdobyć wspomnianą zdolność, przedsiębiorstwa często tworzą w szerszej perspektywie systemy zarządzania popytem, a w węższej – prognozy sprzedażowe. Celem artykułu jest ukazanie konieczności użycia ilościowych metod prognostycznych i wskazanie dalszych kierunków badań związanych z wdrożeniem CPFR w wybranym podmiocie. Główny obszar dotyczący zarządzania popytem będzie skupiał się na koncepcji CPFR. Jedną z wielu zalet CPFR jest poprawa dokładności stawianych prognoz. Druga część artykułu oparta jest na studium przypadku skupiającym się na zastosowaniu podstawowych metod wygładzania wykładniczego i porównaniu rezultatów z dotychczasową metodą prognostyczną, a także ukazuje kierunki dalszych badań związanych z wdrożeniem CPFR.

Słowa kluczowe: CPFR, zarządzanie popytem, prognozowanie, metoda Wintersa.