Modelling Inventory Management System at Distribution Company: Case Study

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Abstract – The paper presents a case study on improving inventory management at the distribution company which operates in Latvia. The case study is focused on application of different modelling approaches in inventory management under uncertain demand, namely inventory models, simulation models and optimization model. The functionality of each model as well as its benefits for the current problem is discussed in the end of the paper.

Keywords - modelling, inventory management

I. INTRODUCTION

Effective distribution company management revolves around balancing the three key dimensions of inventory, cost, and service. Managing these trade-offs efficiently is typical inventory management task which can result for company in improving business performance and driving competitive advantage.

The explored topicality of inventory management system defines the goal of the case study aimed at analysis of the inventory management system in a distribution company (King Coffee Service (KSC), a leader in field of coffee sales and renting of coffee machines in Latvia. Comparing with others, the company offers to its customers full coffee concept – starting from stirrers and paper cups to premium coffee machines, which in total make several hundreds of positions in inventory list. Therefore the analysis of current inventory management system and its enhancement is a high priority for the company. However, the object of the case study is not the inventory management itself, but modeling approaches which can be applied for inventory management task.

Following is the structure of the paper. In the next part, the description of the company KCS inventory management system is presented including ABC analysis. Then, main inventory models are discussed and applied for the case of the company. In the fourth part of the paper, simulation models for above discussed inventory models are developed. An application of optimization model for calculating inventory model's settings is presented as the last modeling approach within current case study. The functionality of each model as well as its benefits for the current problem are discussed in the end of the paper.

II. BACKGROUND

Founded in 2006, KCS's main strategic goal is to become a leader in coffee industry. The company has developed a concept which provides to it's customer the opportunity to rely on the supplier. This means that customers can be confident about the quality of coffee machines, variety and quality of raw materials, and best service including free deliveries of ordered goods. The concept is already recognized by the customers as highly successful, comfortable and economical. Every day KCS's coffee machines prepare thousands of coffee and other hot drinks.

A. Supply chain

KCS is an international company with head office located in Riga (Latvia) and representatives in Lithuania and Estonia. All material flows are managed through Latvia. The company receives goods from manufacturers directly, skipping wholesaler echelon from typical supply chain structure. The inventory is hold in company's private warehouse. However the company rents storage space in a public warehouse in order to achieve best service to its main customer, who has storage space in same place. Other customers, as well as KCS representatives in Baltic are served from KCS's private warehouse.

Lead time from KCS company to the customer is one day, i.e. goods ordered today will be delivered tomorrow. However there are agreements with main customers about certain dates when order can be placed. The goal of KCS in respect to customer is to support 100% service level.

KCS works with several suppliers located in Europe, i.e. Finland, Poland, Swiss, Italy, Holland, France, and Germany. The lead time varies for each supplier, and is not proportional to a distance to customer. Every stock keeping unit has its own lead time despite they are served by one supplier.

B. Inventory management

Inventory of KCS consists of hundreds stock keeping units and can be divided in two main groups: (1) coffee machines and spare parts, and (2) ingredients and raw materials for coffee drinks.

First group is not fast moving, so there is no sufficient inventory kept for this group. Inventory management for the first group belong to pull approach.

Second group is very dynamic with intensive consumption that is why it is selected as an object of the current case study. All goods within second group can be divided into ingredients (including coffee beans, milk powder, chocolate powder, coffee syrups and sugar pre-packed) and raw materials (i.e. paper cups, plastic lids for cups, stirrers, plastic juice cups). The current inventory management for this group belongs to push approach. Inventory replenishment is organized as continuous order review with a period of one day. However, as delivery from suppliers is performed monthly, periodic order review approach and its inventory models should be analyzed as alternative inventory replenishment to be implemented at the company.

C. ABC analysis

As the company operates with hundreds of items, it is decided to cut quantity of goods to the most essential ones. Undoubtedly, that main product is coffee beans, as sales of others depends on consumption of coffee. In order to prove this, as well as for selecting one item from a variety of coffee beans, ABC classification analysis is performed [1]. Within current research following key indicators are selected: total year revenue, one item sales price and total amount of sales. The list of SKU consists of 44 items (some items are grouped before the analysis, as well some seldom and special items are ignored as not typical in daily operations).

ABC classification by total year revenue is very essential for the company as it shows items which require most assets into inventory. These items should be controlled as tight as possible, i.e. low inventory levels and safety stocks to minimize costs. Performing ABC classification by price is less important than total year revenue however is still useful. As group A needs a high level of safety to protect it from any damage (this is very actual for first group goods, i.e. coffee machines). ABC classification by demand has a similar nature with classification by total year revenue. Besides, group A items should be held in the most accessible place in warehouse as they are the most demanded.

An illustration of ABC analyses is shown in Fig.1. Comparing analyses, the conclusion is that both ABC analysis by total year revenue and demand show almost the same result, which is close to theoretical ABC breakdown. In spite of the items in both Groups A are almost the same, they have different ranking. ABC analysis by items total price shows different results as the nature of key parameter is different. The most essential items for the company based on ABC analysis are SP12 Main, Coffee 3200, Topping, Choco powder, Lids 85 mm, SP12 KCS and SP16 Main. However, only three of them are used furthermore, i.e. SP12 Main, Coffee 3200 and Topping.



Fig.1. Comparison of ABC analysis

D. Analysis of demand

To make the analysis of demand for the selected items, statistical information is analyzed over the period of year

2009. As the Fig.2 shows, a weekly demand for all products is unstable. All customers have one free of charge delivery per month. Almost all of them place orders at one time, but there are still some orders during the rest time. Although in terms of a month, fluctuation of demand is smaller (see Fig.3).





Demand for considered products is seasonal, i.e. demand for hot drinks rises in colder months, and falls during summer time. The fall of demand in January is explained by extra stocks made in December approaching Christmas holidays.

As the Fig.3 shows, Topping, Coffee3200, SP12 Main are dependent products, i.e. sales of each product are mutually related. The correlation test is performed by means of Excel Spreadsheet function CORREL. The results show that correlation between Coffe 3200 and Topping is 0,89, and correlation between Coffee 3200 and SP12Main is 0,82. This means that Coffee 3200, Topping and SP12Main closely vary together in the same direction. Moreover, the correlation between Coffe 3200 and Toppin is higher than correlation between Coffee 3200 and SP12. It can be explained by the fact that majority of coffee drinks made from Coffee3200 are filled in SP12Main cups. Topping, a milk powder, is not always used for preparing coffee, as some customers prefer black coffee. However, at this research it is assumed that products are independent. Moreover the rest of the paper will focus on Coffee3200 product only.



Fig.3. Monthly demand

Arena Input Analyzer software is used to find a statistical distribution to describe the demand for Coffee3200 numerically. The statistics on weekly demand is used. The distribution for the product Coffee 3200 is Beta (see Fig.4). It has the smallest square error value among others distribution

(as for example, normal, lognormal, erlang, beta, triangular, and some others). The result of the chi-test, as well as Kolmogorov - Smirnov test, shows that beta distribution can be used to describe empirical data. As it was pointed above, demand has instable nature in terms of weeks, which can be proved by its mean value as 466 and almost the same standard deviation value as 323.



Fig.4. Coffee3200 demand analysis

Finally, demand analysis needs to find out stockout situations if such exist.

As Fig.5 shows, there were not any stockout during year 2009, except week 39 when inventory depleted to 80 kg. The maximum of inventory, i.e. 5196 was hold in week 44. The average inventory level is 2636, which comparing with average weekly demand value is high. However, considering 4 weeks lead time, average amount of inventory is reasonable. Coffee 3200 had 7 deliveries during year 2009. Inventory level never goes lower than 500 kg (except week 39) - which in terms of inventory management can be explained as safety stock empirically obtained in the company.



Fig.5. Weekly inventory

III. INVENTORY MODELS

It is mentioned above, that inventory management for second group of goods is realized as continuous. However, there are several inventory strategies (also called as models) for both periodic and continuous review of inventory. Moreover, there are also practical recommendations for selecting the appropriate strategy based on ABC analysis. For group A it is usually recommended to create a higher level of safety stocks and obtain continues strategy. Group B needs average safety stock level and periodic review. For group C safety stock is not made at all and inventory level is controlled rarely.

Within current paper, calculations are performed for Coffee3200 which is within group A. Taking into account some specific of empirical experience of ordering at the company, following are inventory management strategies selected for case study "Min – Max" (also known as "s-S"), and "s-Q" (continuous inventory models), and "up to S" with "Q-p" (periodic inventory models) [1], [2].

Min Max inventory model has two parameters, i.e. reorder point s and maximum inventory level S. When inventory level falls down to s, order Q is placed to increase inventory up to maximum level S.

s-Q model is similar to s-S, but prescribes that every time, when the inventory level falls to s, new order Q is made. To calculate Q well known EOQ formula can be applied [1].

Up to S model requires that order to supplement inventory to a level S is done once in a definite period of time. The period between orders can be either calculated or acquired in empirical way. In current case study it is calculated by dividing 52 weeks on number of orders in a year (which in its turn is a result of dividing annual demand on order size obtained by EOQ) and is equal to 5.

Q-p strategy prescribes that new order Q is made every period T. Period between orders is discussed above.

The essential to all models is service level. According to the strategy of the company to obtain 100% service level, all calculations are done for service level 95% and 100%. Lead time is considered as constant, 4 weeks. Demand is described by its mean value (i.e. 466) and standard deviation (i.e. 323).

Table 1 summarizes calculations for all inventory models (numbers in brackets show results for service level 100%; the rest is done for 95%; period T is same for both service levels).

CALCULATION RESULTS						
Dogomotogo	Inventory strategy					
Parameters	min-max	s-Q	up to S	Q-p		
S	2930 (3854)	2930 (3854)	-	-		
S	4794 (5718)	-	5954 (7361)	-		
Q	-	2513	-	2513		
Т	-	-	5	5		

TABLE 1 CALCULATION RESULTS

As it is shown in the Table 1, the maximum inventory level for continuous strategy min-max is equal to 5718 (under service level 95%) which is very close to empirical maximum of inventory in year 2009 (i.e. 51960). Same, a lower inventory bound is close to average inventory level in 2009, correspondingly 2930 and 2636. However, to make an effective comparison of all inventory models before implementing one of them, it is decided to use simulation which allows recreating a situation (i.e. inventory management strategy) so that the likelihood of outcomes can be estimated.

IV. MODELING OF INVENTORY STRATEGIES

There are two main modelling techniques used in supply chain management, i.e. simulation and optimization. Both approaches are used for different tasks solving as there is a difference between approaches [3].

While simulation can yield detailed answer to the most frequently asked and well-known question - "What if?" -, only optimization technology allows answering to the question - "What's Best?". Simulation by itself can't guarantee that the modelled system has the optimal performance. The use of simulation allows the decision maker to test the effect of alternative scenarios in order to select the best one. Optimisation models are based on precise mathematical procedures for evaluating alternatives, and they guarantee that the optimum solution has been found to the problem as proposed mathematically. This process determines exactly which combination of factor levels produces the best overall system response. Optimisation problem can be formulated as a task of finding an extreme of the function representing the system. Optimisation of supply chain performance is usually pursued around the goals of cost reduction, capital reduction, and service improvement.

A shortcoming of optimization is simplification. An optimization model can only approach the real system within a certain level of detail, and some factors are usually simplified or left out. Unlike simulation models, optimization cannot handle all uncertainties of the system. These simplifying assumptions should have only a minor effect on the result; otherwise the optimal solution of the simplified model will be useless for the real situation. Therefore, nowadays optimization is used together with simulation. Once the optimization solution is found, the system performance under the optimized value can be tested by means of simulation model.



Fig.6. Schema of experiments

In the current case study, both modelling approaches are implemented. First, simulation models are made in order to compare different inventory strategies. Then, optimisation technique is applied to find parameters for one of the considered inventory strategy, see Fig.6.

A. Simulation models

To evaluate how the company may work according to calculated inventory models' parameters, simulation models are created by means of MS Excel Spreadsheets. Fig.7 shows simulation model interface for Min-Max strategy with 100% service level. Market demand is described by Beta distribution.



Fig.7. Simulation model interface (a fragment)

Simulation models are created for all modelled inventory strategies. They are run for period of 52 weeks with 30 replications. The period of 52 (in weeks) is selected as one which describes the time horizon of tactical decision making whom inventory management belongs to. A number of replications is obtained empirically, however an analysis is made by using confidence interval method to prove the sufficiency of 30 replications [4].

For every replication performance indicators are measured and than average performance indicators values are calculated.

To evaluate the quality of simulation results for all inventory models, following performance indicators are selected [5]:

- P1 service level as a percentage that indicates the chance of demand coverage during the replenishment;
- P2 service level indicates the percentage of demand covered at time;
- average inventory;
- R2 a dispersion of results: as less is *R*, the solution is more robust.

After developing a simulation models, all above discussed inventory models are tested. Table 2 shows obtained results.

As table 2 shows, almost all strategies received good results for performance indicator service level P1 and P2. The worst result is for strategy Q – p. Comparing results with different service level, better ones are for 100% service level which requires higher safety stocks and therefore have higher average inventory level (and related costs). The dispersion of service level R2 allows finding the most robust inventory model. As table 2 shows, this is Min-Max strategy with customer level 100%. The explanation is that by using Min-Max inventory strategy with calculated maximum and minimum inventory levels, the behaviour of the system (i.e. inventory in the company) is more robust.

TABLE 2							
RESULTS: PERFORMANCE INDICATORS							
Strategy	Service level, %	P1	P2	R2, %	Average inventory		
Min-Max	95	0,994	0,999	8	1997		
	100	0,999	1,000	4	2714		
Up to S	95	1,000	0,998	5	2549		
	100	1,000	1,000	6	3750		
s-Q	95	0,995	0,996	8	1892		
	100	1,000	1,000	5	2604		
Q-p		0,953	0,973	34	2380		

Essential to the company operation is inventory level. The higher inventory level is the bigger inventory costs the company has. Comparing the dynamic of inventory level over 52 weeks, the peak of inventory is achieved under Min-Max strategy; however average inventory is higher in case of Up to S inventory strategy. Moreover, as Fig. 8 shows empirical inventory level is similar to Min-Max. This allows making an assumption that KSC is working under Min-Max strategy.



Fig. 8 Comparison of empiric inventory level and Min-Max 95% inventory level

However, before making the final conclusion on inventory strategy to propose for the company, it is decided to use optimisation technique for calculating parameters values for inventory strategy.

B. Optimisation model

Within current research, an optimization model is developed for the Up to S inventory model, where orders are made every period, and orders size is aimed to replenish the current inventory level up to S position. The optimization model for the case of KCS company is adopted based on the model presented in [6],[7]. It is stochastic optimization model with stochastic demand. Echelon number is changed to 3 presenting supplier of Coffee32, the company itself and its customers. The length of the planning horizon in the model is set as 20, where one period is one month. The period of 20 months exceeds the tactical planning horizon of one year, however it is necessary to allow model operating stable after warm-up period. The decision variable which the model is aimed to find by minimizing total costs over planned horizon is target inventory level S. The lead time shows transportation time from a supplier to the company, and in case of Coffe32 it is 4 weeks (or one period in terms of the optimization model).

Customer demand is very essential for the optimization model because of it stochastic nature. To describe the demand

a scenario approach of stochastic programming is used (for more explanation of scenario approach in stochastic programming see [8]). It allows representing the uncertainty of the future by a scenario which is the particular succession of possible random parameter's values (samples) over the periods in time horizon. Usually, to have more realistic results the set of scenarios is used. This is also one of the biggest challenges in scenario approach. Within current case study the number of scenarios is set to 100. This means that there are 100 different scenarios of demand for 20 periods. The number of 100 is chosen empirically based on pre-analysis of results of the optimization model under different scenario size, however for future research Sample Average Approximation method should be applied to evaluate the confidence and quality of the obtained solution [5]. Each scenario value is generated from the statistical distribution which described empirical data of demand for Coffee 3200. Monthly demand for Coffe32 is described by triangular distribution.

The objective function of the optimization model is aimed at minimizing the total costs of the supply chain during the period of 20 months over all 100 scenarios. The total costs are the sum of inventory costs and backlog costs. This is done for balancing inventory costs with customer level as high backlog costs are related to low customer service. The inventory costs are calculated as inventory hold during all periods over all scenarios. Same backlog costs are equal to the amount of backlogs during all periods for all scenarios. The inventory costs is defined as 1 unit, however backlogs are penalized with 2 units for every backlog within current case study, however some future research will be done in order to find the best ratio of inventory and backlog costs for the company.

Additionally to objective function, the set of conditions is presented in the optimization model to describe the logic of Up to S inventory model. In total there are nine subjects to define the supply chain performance during the time horizon of 20 periods. For example, one defines that backlog at the period t is equal to the backlog in previous period (t-1) plus demand for the current period t and minus deliveries to customer to satisfy the current demand. Other subjects are explained in [6],[7]. The described model is written in AMPL algebraic modelling language and solved by using Cplex solver. The solution of optimisation model is target inventory level S equal to 4234 units. However, to check the quality of obtained solution the developed simulation model for up to S strategy is run with optimized S value.

C. Comparing results

For comparing simulation results of all inventory strategies (including optimized Up to S strategy), a multi criteria analysis of all inventory models is done applying a weighted sum method. Performance indicators of simulation models are used as criteria, i.e. P1, P2, R2 and average inventory.

Criteria with equal weight are used first (Case 1 in Table 3). A conclusion is that strategy s-Q with service level 95 % is the most reasonable, as it has the highest total weight. Optimized Up to S strategy takes a second place in ranking. The smallest total weight belongs to Q-p strategy.

TABLE 3							
COMPARISON OF INVENTORY STRATEGIES							
Strategy	Service Level, %	Case 1	Case 2				
Min-Max	95%	0,844	0,806				
	100%	0,831	0,789				
Up to S	95%	0,834	0,793				
	100%	0,765	0,706				
s-Q	95%	0,849	0,813				
	100%	0,832	0,790				
Q-p		0,649	0,573				
Up to S_opt		0,838	0,807				

Next, criteria weights are changed according to goals of the company on providing service level as high as possible (P1=0.4, P2=0.2, R2=0.2 and average inventory=0.2), see Case 2 in Table 3. Results show that best strategies with almost same resulted sum are s-Q (95%) and Min-Max (95%). Q-p strategy shows the worst results in ranking.

V.CONCLUSIONS

Inventory management is an important sector of logistics and economic spheres, company's growth and success is strictly dependent on it. Even empiric experience may help to manage inventory well, application of managerial theory allows analyzing future improvements.

There is a variety of inventory management strategies all answering same questions, i.e. When to order? and How much to order? To answer them, different approaches can be applied namely inventory models, simulation, and optimisation.

Traditional inventory strategies expressed by means of analytic formulas are the most popular. However, a complexity of analytic inventory models increases if stochastic data appears. If demand and lead time are stochastic (as they use to be in practice), computation of the optimal order quantity will be more complex. Application of analytical formulas is only then useful, if there is no necessity for complex adoption inventory models for any certain case which requires from a manager good mathematical skills and creativity.

In order to check and evaluate results of system operation under defined inventory models settings (found either by using inventory models or empirically) before implementing them to the company a simulation model can be used. However, to create a good simulation model, input data should be defined accurately and a model should capture logic of the modelled system. For example, if Min-Max strategy is modelled, then a model should operate based on Min-Max conditions. Once created, a simulation model can be multiply used then for performing so called "what-if" analysis. Illustratively, a manager can use the simulation model to evaluate how the system will operate in case of increasing/decreasing demand.

Besides analytical models for inventory management, optimization model allow finding parameters of inventory models as well. Application of scenario approach of stochastic programming in inventory management is then rational if there is some lack of data required for traditional analytic algorithms, as for example mean and dispersion of demand or lead time cannot be precisely expressed. However, better benefit optimisation models give in case of planning inventory in multi echelon supply chain, because they allow describing interconnections of echelon in managing inventory toward the end customer.

The case study is focused on enhancement of inventory management system in the company KCS". An empirical study is conducted to analyze current situation of the inventory management in the company. However the detailed analysis is done for one product, i.e. Coffee 3200, which is leading for the company. Simulation results show that two inventory strategies from four can be investigated in the company. They are s-Q and Min-Max strategy. However, taking into consideration that current strategy maintained in the company is similar to Min-Max strategy, the recommendation is to follow Min-Max strategy until the future analysis is conducted in order to find inventory strategy for depended and consolidated goods. The practical implementation of any new strategy will take some effort whilst Min-Max strategy requires only re-calculating its parameters, i.e. min and max.

During the research within current case study, some further research directions are defined as important for the company. Following are main of them:

• As the company has a certain amount of suppliers what delivers more than one inventory position (i.e. product), the solution is needed to consolidate the orders from same suppliers to decrease transportation costs.

• As it is concluded, that the company operated with dependent products, it is necessary to make a review on inventory models which deal with dependent products.

• To react fast on rapidly changing environment (for example, demand), forecasting methods have to be considered before planning inventory. Till now demand forecasting is only based on the manager competencies. In spite of the fact that this practice has worked well, the necessity of implementing a forecasting is obvious.

Another significant direction for academic purposes is related to applying optimization model for other inventory strategies (i.e. Min-Max etc.).

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Oksana Soško, Vilmārs Vjakse, Jurijs Merkurjevs. Krājumu vadības sistēmas modelēšana sadales uzņēmumā: problēmsituācijas analīze

Rakstā ir aprakstīta gadījuma izpēte par krājumu vadības sistēmas pilnveidošanu Latvijas sadales uzņēmumā. Īpaša uzmanība ir pievērsta dažādu metožu pielietošanai krājumu vadības sistēmu modelēšanā ar nenoteiktu pieprasījumu, tādām kā krājumu vadība, imitācijas modelēšana un optimizācija. Veiktā gadījumu izpēte iekļauj vairākus posmus. Sākumā tiek veikta esošās krājumu vadības sistēmas analīze, tai skaitā preču klasifikācija, krājumu pozīciju ABC analīze, pieprasījuma statistiskā analīze utt. Pēc tam četras krājumu vadības stratēģijas tiek izmantotas, lai aprēķinātu pasūtījumu daudzumu un laiku vienam produktam. Lai novērtētu sistēmas darbību ar aprēķinātajiem krājumu vadības stratēģiju parametriem, tiek izstrādāti imitācijas modeļi elektronisko tabulu Excel vidē. Izmantojot šos modeļus, uzņēmuma vadība var izanalizēt krājumu līmeni un klientu apkalpošanas līmeni dažādās stratēģijās. Papildus imitācijas modeļiem pētījumā tiek izmantots arī optimizācijas modeļis, lai aprēķinātu optimālo mērķa krājumu līmeni Up to S stratēģija. Šis modelis pieder stohastiskās programmēšanas pieejai, kurā stohastiskie faktori ir attēloti scenāriju koka veidā. Up to S krājumu stratēģijas modeļi. Krājumu vadības stratēģiju salīdzināšanai, ieskaitot arī stratēģiju ar optimizēto mērķa līmeni pēc tam tiek vēlreiz palaista imitācijas modelī. Krājumu vadības stratēģiju salīdzināšanai, ieskaitot arī stratēģiju ar optimizēto parametru, tiek izmantota svērtās summas metode. Tās rezultāti rāda, ka labākās stratēģijas uzņēmumam ir s-Q un Min-Max. Gadījuma izpētes rezultātā uzņēmumam ir rekomendēts realizēt Min-Max krājumu vadības stratēģijai.

Оксана Сошко, Вилмарс Вяксе, Юрий Меркурьев. Моделирование системы управления запасами в дистрибьюторной компании: практический пример

В статье представлено исследование системы управления запасами на примере дистрибьюторной компании, работающей в Латвии. Целью исследования является улучшение системы управления запасами, используя различные подходы моделирования запасов в условиях неопределенного спроса, такие как модели управления запасами, имитационное моделирование и оптимизация. Проведенное исследование состоит из нескольких частей. Вначале проводится анализ существующей системы управления запасами в компании, включая класификацию товаров, анализ запасов по методу ABC, статистический анализ спроса и т.д. Затем четыре стратегии управления запасами применяются для расчета размера заказа и времени заказа для однго из продуктов. Далее имитационные модели используются для оценки работы системы управления запасами, оперирующей согласно расчитанным параметрам стратегий управления запасами. Разработанные в среде электронных таблиц Excel, эти модели позволяют руководству компании оценить эффект применения различных стратегий на уровень запасов и уровень обслуживания клиентов. Помимо имитационных моделей в исследовании используется оптимизационных котратегий и уровень запасов и уровень обслуживания клиентов. Помимо имитационных моделей в исследовании используется оптимизационных моделей, которая позволяют расчитать целевой уровень запасов в стратегии Up to S. Эта моделей в исследовании используется оптимизационных моделей, где стохастические данные представлены в виде дерева сценариев. Полученные результаты плиизационной модели проверены с помощью имитационной модели. В заключении для сравнения всех стратегий управления запасами используется модели. В заключении для сравнения всех стратегий управления запасами используется метод взвешенной суммы. Результаты указывают, что лучшии стратегии для компании и вляются s-Q и Min-Max. Однако заключительная рекомендация для компании состоит в применении стратегии Min-Max, т.к. существующий подход управления запасами на предприятии очень близок к рекомендуемой стратегии.