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Comparison between the models of potential storage and simulation of the demand for electricity transformer (400/11) in Diyala General Company

Azhar Hussein Alwan [1, a)], Abdul Moneim Kazem Hammadi [2, b)], Ali Jabbar Al-Shimmari[3, c)]

[1] College of Basic Education, Diyala University, Baghdad, Iraq

[2] Faculty of Administration and Economics, Al-Amin Private University, Baghdad, Iraq

[3] Al Hikma University College, Baghdad, Iraq

[a)] Corresponding author: azharhussein@uodiyala.edu.iq

[b)] Abdulmunaam.k.Hamadi@gmail.com

[c)] hicnas.2024@hiuc.edu.iq

Abstract. Storage models are usually used to determine the optimal order quantity and reorder point by obtaining the lowest total cost of storage to balance the amount of production and the amount of demand for materials, but sometimes these models can not be applied, so the use of simulation is resorted to where accurate and flexible results can be relied upon, to achieve the goal of the study, which is to improve the company's storage system. This research dealt with two cases of the probabilistic storage model, where the first model was applied to the monthly demand data on one of the products of Diyala General Company, which is the distribution transformer (400|11) for the years 2019,2020,2021. The second is the probabilistic storage model by simulating demand and comparing the two models, whichever is better to reach optimal. Where the distribution of demand was found to find the average and standard deviation and apply the model to obtain the indicators of the models. Using the MATLAB program, the statistical analysis of the data was carried out and the indicators of the model were obtained.

Keywords: probabilistic storage model, total projected cost, reorder point, simulation.

INTRODUCTION

The issue of control of storage is of great importance in all industrial and production companies and institutions. The storage model is one of the scientific foundations in determining storage indicators such as the quantity of the order and the period of time that determines when it is re-ordered (in the case of purchase or production). In practice, the quantities of demand for storage materials are variable, depending on the demand and size of the materials. The waiting time may also be variable, depending on the conditions of the processors that affect the arrival of orders and their delay from the specified time sometimes. Therefore, there is a problem in finding the optimal quantity for storage, the best time for issuing a supply order, and the optimal quantity for the order. Due to the special importance of this subject in most establishments, which aims to reduce the costs of storage, continuous research on this subject is important in the work of the authorities responsible for storage.

Research problem

The problem of research is to determine the optimal economic size for the production of distribution transformers in Diyala General Company in light of random demand and compare it with random demand using simulation to achieve the main goal of storage, which is to reduce the expected total cost and thus achieve the main goal, which is the permanent processing of any demand on the quality of the product.

Research objective Purpose of search

The research aims to compare the two models of ordinary probabilistic storage and the model of probabilistic storage using simulation to find out which of the two models achieves the optimal economic production quantity at the lowest expected total cost of storage and to determine the best point for reorder and reduce the amount of expected deficit to a certain extent, which leads to the best management of storage and more accurate, which leads to the determination of accurate quantities of the level of storage to ensure that the total cost is reduced to the lowest possible level.

Storage Inventory

The concept of storage:

Storage is one of the fundamentals of the work of the company or institution regardless of the type of activity or work practiced by that company because it is linked to different exchanges and commercial agreements. Many researchers dealt with the definition of storage, where (Al-Najjar et al., 1990) defined storage as "any amount of materials (raw materials, operating materials, finished products) that are under the control of an establishment and kept for a certain period of time pending their use or sale", as well as the definition (Obeidat, 2008) as "raw, semi-finished or finished materials or spare parts that are in stock pending their use in the future", and the definition of (Al-Shamarti, 2010) of storage was "the quantities held of raw materials, reserve tools, semi-finished parts and finished goods that were purchased or produced by the establishment" In addition to the definition of (2008 Kumar& Suresh) that storage "is the materials or items kept in stores and the storage is called" inactive supplier "and includes items stored for the purpose of sale or for the purpose of production operations in the company, as certain quantities of storage are kept for the purpose of fulfilling orders during waiting periods and thus maintain the efficiency of the company's work"

Storage costs: Inventory cost

The costs of storage can be divided into several types, the most important of which are [1]:

First: Purchasing or Production Cost: Purchasing or Production Cost

This cost is usually fixed and may change in the event of the purchase or production of larger quantities and can sometimes get a discount in prices.

Second: The cost of issuing the order: Setup cost

It is the cost that occurs once the application is submitted and is fixed and calculated for each application and includes several costs (costs of preparing and receiving orders, printing documents, workers' wages to follow up, correspondence and stamps, transportation cost, as well as vacation costs that affect stored materials).

Third: Holding cost: Holding cost

This cost includes all storage expenses such as renting storage places, wages of warehouse workers, and all costs necessary to keep the storage, including (heating, cooling and safety systems and all supplies required to keep the storage in its normal form) as well as interest, insurance and consumption.

Fourth: Shortage cost:

It is the loss achieved in the event that certain materials are not provided in the warehouse when needed or requested in one of the two cases:

The cost resulting from the implementation of a previous or deferred request and it must be implemented when providing materials and the consequent delay fines due to the delay in processing in addition to the impact on the reputation of the shop.

Lost profits from lost sales in a given quarter

Inventory models:

Storage models are divided according to the type of demand for stored materials into two main sections:

First: Deterministic inventory models

They are models that deal with storage problems when the demand for stored materials is specific and known during the time period and the specific storage models are either for one commodity or for multiple commodities.

Second: Probabilistic inventory models: Probabilistic inventory models

These models assume that some of the variables that enter the model are uncertain due to sudden conditions and situations in the market that lead to making the demand uncertain and unpredictable. Therefore, probability theory is used to address it by finding a certain probability distribution for it. Therefore, the parameters of this probability model enter in the case of uncertainty as random variables, as the demand is unknown to the decision-maker, but it is possible that it is known through the probability distribution during the specified period.]3

Some concepts used in the field of inventory control

Demand

The demand for the material is one of the factors that directly affect the determination of the volume of the order during different time periods.

Lead Time

The period of time starting from the date of issuance of the order purchase order to the date of receipt of the materials of this order [4].

Order Quantity

It is the amount added to the stock when it reaches the level of the re-order point to raise its level to another level and is symbolized by the symbol Q.

Re-order point

The re-order point, which is the level of storage upon reaching it, must issue a new order to ensure that the order reaches before the storage level reaches the safety limit or (zero), taking into account that the volume of storage in the event of reaching the re-order point is sufficient to meet the demand during the supply period [9].

Stock Review Duration

The low level of storage needs to be monitored during different periods. This period is called the storage review period, [4] and it is done in one of two ways:

A - Periodic Review

In this model, the records of the stock level are reviewed at fixed periods of time, that is, the stock level is monitored periodically every (several days, every week, more or every month,...etc.) to re-order and this period is determined by the company or institution and according to the level of storage and demand during the review period

B- Ongoing review: Ongoing review

The continuous review form is one of the storage policies for storage management. The level of storage in this form is monitored continuously to determine the level of re-order. When the level of storage reaches the re-order point, a new order is requested. This model aims to determine the level of re-order and the optimal economic quantity of the order to reduce the expected total cost of storage during a period of time [8]

The mathematical formula for the probabilistic storage model

The demand in this model represents a random variable with a known probability distribution, and the expected value of the demand will be found and the expected total cost of storage will be reduced. It is necessary to know the mathematical symbols used for this, as follows [3]:

D: demand per time unit

σ: Standard deviation of demand

X: The quantity of the order during the waiting period, which is a random variable that follows a probability distribution with a probability density f(x)

Y: Quantity Required per Stock Cycle

K: Safety factor

Reorder Point

h: Storage holding cost per unit

P: Deficit cost per unit

s: Expected deficit per stock cycle

A: Cost per order

f Standard Normal Distribution Probability Density Function

Values of the distribution function for a standard normal distribution.

The main objective of the probabilistic model is to determine the values of Y and R that make the total cost as low as possible, which consists of (order cost, storage cost and deficit cost) per unit of time and as follows:

1. setup cost

   Represents the expected number of stock cycles per unit of time

$$\text{setup cost} = A(D/Y) \tag{1}$$

2. Holding cost

   The expected value of the number of units during the stock cycle is equal to (the expected value of the stock level at the beginning of the cycle + the expected value of the stock level at the end of the cycle) \2

   Expected value of the stock level at the beginning of the cycle =Y+E(R-X)

   Expected value of the stock level at the end of the cycle =E(R-X)

$$E(R-X) = \int_0^\infty (R-X)f(x)dx \quad , \quad E(X) = \int_0^\infty (X)f(x)dx \quad , \quad (R) = \int_0^\infty (R)f(x)dx$$

$$= R - E(X)$$

   Thus, the expected value of the units stored during the stock cycle is equal to:

$$I = \frac{Y}{2} + R - E(X) = \frac{(Y + E(R-X)) + E(R-X)}{2}$$

   and the expected storage cost in the unit of $\left[\frac{Y}{2}+R-E(X)\right]$ time

   Thus, the cost of holding the storage can be extracted in the formula

$$\text{holding cost} = h\left[\frac{Y}{2}+R-E(X)\right] \tag{2}$$

3. Cost of Deficit:

   Expected quantity of deficit per cycle

$$\int_R^\infty (X-R)f(x)dx$$

$$S(X) = \begin{cases} 0 & X \le R \\ X-R & X > R \end{cases}$$

   Expected value of the number of deficit units for the stock cycle $\bar{S}$

$$\bar{S} = E\{S(X)\} = \int_0^\infty S(X)f(x) = \int_0^R 0\, f(x)dx + \int_R^\infty (X-R)f(x)dx = \int_0^\infty (X-R)f(x)dx$$

Since it is P proportional to the amount of the deficit only, the expected cost of the deficit for the cycle is $P\bar{S}$ and the D/Y number of cycles per unit of time, the cost of the deficit in the unit of time is equal to

$$\text{Shortage cost} = P\bar{S}\frac{D}{Y} \quad (3)$$

Thus, the expected value of the total cost in the unit of time can be obtained in terms of the variables R and Y, which is symbolized by the symbol TAC(Y,R)

TAC(Y,R) =setup cost+holding cost+shortage cost

$$K\frac{D}{Y} + h\left[\frac{Y}{2}+R-E(X)\right] + P\bar{S}\frac{D}{Y} \quad (4)$$

To obtain the values of R* and Y*, we partially derive the above equation and make it equal to zero

$$\frac{\partial TAC}{\partial Y} = -K\frac{D}{Y^2} + \frac{h}{2} - P\bar{S}\frac{D}{Y^2} = 0$$

$$\frac{\partial TAC}{\partial R} = h - P\frac{D}{Y}\int_R^\infty f(x)dx = 0$$

Thus, we get:

$$\sqrt{\frac{2D(K+P\bar{S})}{h}} \quad (5)$$

$$\int_R^\infty f(x)dx = \frac{h\check{Y}}{PD} \quad (6)$$

The process of finding the optimal values of both R* and Y* in the previous two linear equations is very difficult, so an appropriate numerical method is used to solve them, such as the procedure developed by (Hadley and Witten) to reach a solution after a specific number of adjustments, provided that there is a solution to the two equations

The value of S will be at least zero in the first equation, which shows that the smallest value of Y* √(2DK/h) is the same result that can be obtained when (S=0) or (R→∞)

If R=0 of equations (5) and(6), we get

$$\sqrt{\frac{2D(K+PE(X))}{h}} \quad (7)$$

$=\hat{Y}=Y^*$

We also get

$$\frac{PD}{h} = \tilde{Y} = Y \quad (8)$$

It is possible to prove the values of Y and R are optimal and single values if they are $\tilde{Y} \geq Y^*$

the minimum value of Y* is is $\check{Y} = \sqrt{\frac{2DK}{h}}$ and is when S = 0

Step 0 1 let Y1= Y* =√(2DK/h) and let R0=0 set i = 1

Step i 2 use Yi to determine Ri from (6)

-if Ri ≈ Ri-1 then stop , the optimal solution is Y* = Yi and R* = Ri

-otherwise use Ri in eq(5) to complet Yi let i=i+1 and repet to step i 2

Simulation

It is one of the mathematical methods to address problems and can be implemented by a computer in which certain types of mathematical and logical relationships are necessary to describe the behavior of a complex real-world system for long periods of time [5].

There are complex problems that the company or institution may face. It is difficult to find experiments and models for the study. It may be expensive sometimes or contain risks at other times. Therefore, it simulates the system using a set of mathematical and logical relationships to determine the behavior of the system to run it according to different conditions and standards to obtain outputs that facilitate the decision-making process. Typically, simulation models are classified into three categories (Monte Carlo model, operational match, and systems simulation). Despite the difference between the three categories, the great development of computerized simulation, which led to the creation of the general foundations for the procedures of their use, the differences became invisible. We will address the Monte Carlo model because it is one of the most popular and widely used methods for probabilistic problems.

Monte Carlo Model: [3]

This method is used to solve problems based on probabilities and is considered simulated by sample methods, meaning that instead of taking samples from the real community, samples are taken from a similar community (a theoretical community). The probability distribution of the variable under study is determined and then the sample is taken from the distribution by random numbers, and a set of values is extracted that have the characteristics of the distribution of the system itself to be simulated using random numbers. The basis of the Monte Carlo model is the experiment on opportunities (or probabilities) through the use of random samples and is done through five steps, which are:

Finding the probability distribution of the variable.
Finding the cumulative probability distribution of the variable in step 1.
Setting a time range for random numbers of the variable.
Creating random numbers.
simulation of a series of actual attempts.
Research sample

Diyala General Company is one of the important institutions affiliated with the Ministry of Industry and manufactures several electrical products, including electrical distribution transformers. The transformer (400/11) was chosen as the most in demand. These transformers, after production, are stored in full production stores for the purpose of marketing them upon demand. The company's warehouses operate the FIFO system (First In First Out), meaning that the materials entered first come out first, and the output of the materials is sequenced according to the oldest entry to the output of the entries.

To implement the study in question, the company's monthly data for the years 2019,2020,2021 were relied upon for the production and costs of the distribution transformer (400/11) produced in the Diyala General Company, which is one of the companies affiliated with the Iraqi Ministry of Industry and Minerals. The researcher obtained the quantities of demand, production, and quantities stored of the transformed product in addition to the costs of those transformed and shown in Table No. (1).

Table No. (1) Details of the monthly request from the transferor 400/11 for the years 2019,2020,2021

Month	Order Quantity Month (Transferred/Month)		
	2019	2020	2021
January	40	233	72
February	65	319	180
March	285	12	152
April	194	75	311
May	173	201	318
June	87	3	2
July	10	202	75
August	74	137	267
September	296	80	278
October	40	47	166
November	282	117	156
December	370	68	315

Costs of Distribution Transformer (400/11) :

After visiting the headquarters of Diyala General Company several times and repeated meetings with officials and employees in several departments, including (financial affairs, marketing, warehouses and planning) in addition to the distribution transformer factory and reviewing the stages of production and its costs, the cost, production and storage data for the distribution transformer mentioned above was obtained and as shown in Table No. (2)

Table No. (2) shows the details of the annual cost of production of the distribution transformer (400/11) for the years 2019,2020,2021

Year	Salaries and wages (dinars)	Raw materials and services (in dinars/year)	Depreciations (in dinars/year)	Total production cost (in dinars/year)
2019	3,419,614,200	20,906,309,400	999,674,400	25,325,598,000
2020	3,095,959,200	8,515,042,800	966,850,200	12,577,852,200
2021	3,154,521,000	15,527,392,200	858,759,000	19,540,672,200
Total	9,670,094,400	44,948,744,400	2,825,283,600	57,444,122,400
Rate	3,223,364,800	14,982,914,800	941,761,200	19,148,040,800

Production quantity per (Transferred/year)	Cost of production per unit (in dinars)	Cost of preparing the order A (in dinars/year)	Deficit cost per unit per year P (dinars)	Cost of storage per transformer h (in dinars)
2,546	9,947,211	045	907	6 397
1,835	6,854,415	375	3,735	4,265
2,252	8,677,030	663	3,853	6,821
6,633	25,478,656	156	495	483
2,211	8,492,885	028	832	5,828

Probabilistic Inventory Models

In this paragraph, two models of probabilistic storage will be applied according to the algorithms that have been prepared, which are based on the demand data of the product, so that we can obtain the final results and discuss them. Since the data were tested using the Kolmogorov-Smirnov test and as shown in Table No. (3) and Figure No. (1), it was found that they follow the normal distribution with an average of (158.39) and a standard deviation of (109.91).

Table No. (3) shows the test of the monthly demand data transferred to the distribution (400/11) for the years

Kolmogorov-Smirnov					
Sample Size			36		
Statistic			0.15866		
P-Value			0.29309		
Rank			32		
	0.2	0.1	0.05	0.02	0.01
Critical Value	0.17418	1991.	22119	0.24732	0.26532
rejected	No	No	No	No	No

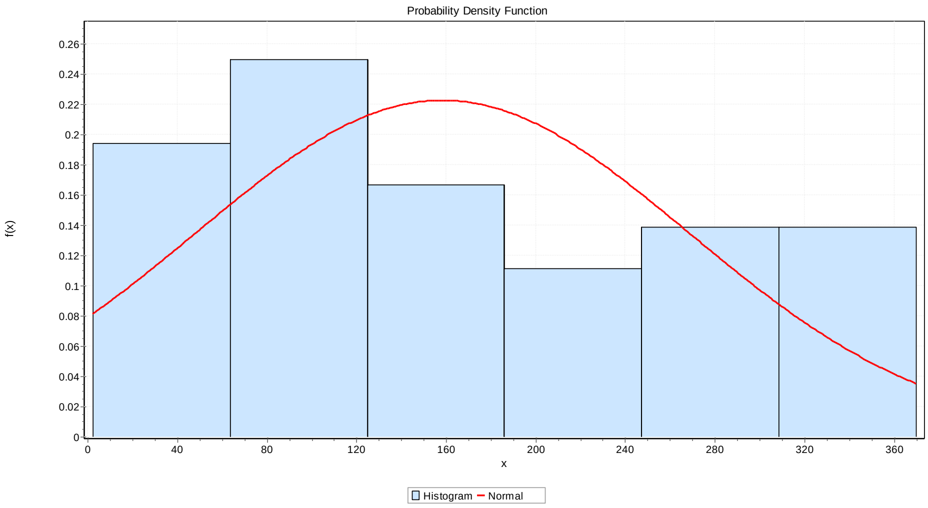

Figure No. (1) represents the normal distribution of monthly demand data

Accordingly, the normal distribution function will be derived after entering it in the agency model: [1]

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma}} \qquad \infty\,'\,\infty\infty$$

$$0\times\infty \quad ....(18)$$

$$\bar{S} = \int_R^{\infty} (X - R) \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma}} dx.. \qquad (19)$$

By adding and subtracting μ from the amount, $(X - R)$ we get $[\,X - \mu + (\mu - R)]$

$$\bar{S} = \int_R^{\infty} [\,(X - \mu) + (\mu - R)] \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma}} dx. \qquad (20)$$

$$\bar{S} = \int_R^{\infty} \left[\frac{X-\mu}{\sigma} + \frac{\mu - R}{\sigma}\right] \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{(x-\mu)^2}{2\sigma}} dx$$

Assume that : $\quad Y=\frac{X-\mu}{\sigma}$

$$dy\frac{1}{\sigma}\ dx \quad . \qquad \sigma\, dy = dx$$

$$\bar{S} = \sigma \int_{\frac{R-\mu}{\sigma}}^{\infty} y \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy + \int_{\frac{R-\mu}{\sigma}}^{\infty} (\mu - R) \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy$$

$$\bar{S} = \sigma \int_{\frac{R-\mu}{\sigma}}^{\infty} y e^{-\frac{y^2}{2}} \frac{1}{\sqrt{2\pi}} dy + \int_{\frac{R-\mu}{\sigma}}^{\infty} \frac{1}{\sqrt{2\pi}} e^{-\frac{y^2}{2}} dy. \qquad (21)$$

We simplify the first term

$$1\ \sigma \int_{\frac{R-\mu}{\sigma}}^{\infty} y e^{-\frac{y^2}{2}} \frac{1}{\sqrt{2\pi}} dy = \sigma \frac{1}{\sqrt{2\pi}} \int_{\frac{R-\mu}{\sigma}}^{\infty} y e^{-\frac{y^2}{2}} dy$$

$$\sigma\, f\left(\frac{R-\mu}{\sigma}\right) \frac{1}{\sqrt{2\pi}} \left[e^{-\frac{(x-\mu)^2}{2\sigma^2}}\right] \sigma[22] \frac{1}{\sqrt{2\pi}} \left[e^{-\frac{y^2}{2}}\right] \frac{R-\mu}{\sigma}$$

$$2\text{- } F(R) = \int_{\infty}^{R} f(x)\, dx$$

$$1\text{- } F(R) = \int_R^{\infty} f(x)\, dx = \bar{F}\,(R)$$

$$(\mu\text{-}R) \int_{\frac{R-\mu}{\sigma}}^{\infty} e^{-\frac{y^2}{2}}\ dy = (\mu\text{-}R)\bar{F}\left(\frac{R-\mu}{\sigma}\right)$$

$$\bar{S} = \sigma f\left(\frac{R-\mu}{\sigma}\right) + (\mu - R)\bar{F}\left(\frac{R-\mu}{\sigma}\right) 23$$

First: The probabilistic storage model

In this model, the data collected from the company's records were used and the model will be applied for each year according to the following algorithm:

Enter the values (A.P.h.μ.σ.D) mentioned in the tables for each year in addition to the level of service (K) ,which is (0.97) based on the company's information.

Calculate my value Y ̂ and (Y) ̃

$$\hat{Y} = \sqrt{\frac{2D(K + PE(X))}{h}}$$

$$\tilde{Y} = \frac{PD}{h}$$

Conducting the basic test between $\hat{Y}$ and and $\tilde{Y}$ if $\tilde{Y} > \hat{Y}$ we move to the next step

Calculate the value of $\sqrt{\frac{2DK}{h}}$ **=Yi**

Finding the Ri Value by Substituting the Calculated Yi Value in the Relationship

$$\int_R^\infty f(x)dx = \frac{hY}{PD}$$

Finding a value $\bar{S}$ from the relationship

$$\bar{S} = \sigma f\left(\frac{R-\mu}{\sigma}\right) + (\mu - R)\bar{F}\left(\frac{R-\mu}{\sigma}\right)$$

Finding the value of Yi+1 and then finding the value of i+1 R and so this procedure is repeated until reaching two consecutive and almost equal values of R and at this point we get the optimal values of R and Y.

Finding the Total Expected Cost

$$TAC(Y.R) = K\frac{D}{Y} + h[\frac{Y}{2} + R - E(X)] + P\bar{S}\frac{D}{Y}$$

The statistical analysis was carried out using the MATLAB program and obtained the results of the indicators of the probabilistic storage model as shown in Table No. (4):

Table No. (4) Results of the model of probabilistic storage of ordinary data for the years 2019,2020,2021

Indicator	Value
$\hat{Y}$	884
$\tilde{Y}$	499
Optimum reorder point (converted)	208
Optimum Order Quantity (Transferred)	392
Projected Deficit (Transferred)	25
Expected Cost of Retaining Storage (JD)	3833126
Expected cost of disability (JD)	2199298
Expected cost of order preparation (JD)	1194513
Expected value of the total cost (JD)	7226937

We note that when the level of storage reaches (208) converted, the optimal amount of storage enhancement is (392) converted, and the expected cost of preparing the order is (1194513) dinars, and the expected deficit is (25) converted at an expected cost of (2199298) dinars, in addition to the expected cost of maintaining the storage is (3833126) dinars and the expected value of the total cost is (7226937) dinars.

Second: The model of probabilistic storage using simulation:

In this model, the monthly demand will be simulated using the "Monte Carlo" method, as the basis of this method is to test the probability of the data through the random sample as in Table (5)

Table (5) Cumulative distribution of monthly demand for the years 2019,2020,2021

Categories	Frequencies	Relative frequency	Ascending Cumulative Frequency	Cumulative Downward Frequency	Midvalue
2-62	7	0.19	0.19	0	32
63	9	0.25	0.44	0.20	93
184	6	0.17	0.61	0.45	154
245	4	0.11	0.72	0.62	215
306	5	0.14	0.86	0.73	276
370	5	0.14	1.00	0.87	338

The cumulative probabilities help to test and assign random numbers. The Excel program was used to generate random numbers for the monthly demand of a sample of 1000. The arithmetic mean and standard deviation were calculated and the algorithm used in the first model was applied to obtain the storage indicators shown in the table

Table No. (6) Results of the probabilistic storage model using simulation for the years 2019,2020,2021

Indicator	Value
$\hat{Y}$	.918
$\tilde{Y}$	499
Optimum reorder point (converted)	219
Optimum Order Quantity (Transferred)	380
Projected Deficit (Transferred)	23
Expected Cost of Retaining Storage (JD)	3647069
Expected cost of disability (JD)	2087250
Expected cost of order preparation (JD)	1232234
Expected value of the total cost (JD)	6966553

We note that when the level of storage reaches (219) converted, the optimal amount of storage enhancement is (380) converted, and the expected cost of preparing the order is (1232234) dinars, and the expected deficit is (23) converted at an expected cost of (2087250) dinars, in addition to the expected cost of maintaining the storage is (3647069) dinars and the expected value of the total cost is (6966553) dinars.

ANALYZING RESULTS

The distribution of the monthly demand for the transformer 400/11 in Diyala General Company follows the normal distribution

By observing the results obtained from the first probabilistic storage model using monthly demand data and the second using simulation, we will compare the indicators of the two models in tables (5) and (6). We find that the value of the optimal reorder point and the expected value of the total cost in the probabilistic storage model are lower than their counterparts using simulation. As for the optimal quantity of demand, the expected cost of holding the storage and the expected cost of preparing the order in the probabilistic storage model are higher than their counterparts using simulation. Therefore, the probabilistic storage models using simulation are more effective and flexible than the usual probabilistic storage models in determining the optimal storage and production solutions for decision-makers because the optimal demand quantity is lower and leads to a high expected cost with a higher deficit amount and large deficit costs in the ordinary storage model.

Simulation methods are of great importance in finding approximate optimal solutions to storage problems for ease of implementation due to the difficulties that can be faced when finding data or samples.

RECOMMENDATIONS

Conducting more research and studies in the field of storage control using simulations to apply them to production institutions and companies because they lack storage control systems based on scientific and modern methods.

Develop annual production plans based on modern scientific methods to determine the optimal production quantity instead of relying on personal experiences and skills.

Applying software to analyze data, solve mathematical models and simulation processing on computers to assist in decision-making.

The optimal number and quantity of orders should be controlled to reduce the expected cost, and this can only be done using storage models and simulation methods.

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