Problem Overview :

Case Problem -Specialty Toys Specialty Toys, Inc., sells a variety of new and innovative children's toys. Management learned that the preholiday season is the best time to introduce a new toy, because many families use this time to look for new ideas for December holiday gifts. When Specialty discovers a new toy with good market potential, it chooses an October market entry date. In order to get toys in its stores by October, Specialty places one-time orders with its manufacturers in June or July of each year. Demand for children's toys can be highly volatile. If a new toy catches on, a sense of shortage in the marketplace often increases the demand to high levels and large profits can be realized. However, new toys can also flop, leaving Specialty stuck with high levels of inventory that must be sold at reduced prices. The most important question the company faces is deciding how many units of a new toy should be purchased to meet anticipated sales demand. If too few are purchased, sales will be lost; if too many are purchased, profits will be reduced because of low prices realized in clearance sales. For the coming season, Specialty plans to introduce a new product called Weather Teddy. This variation of a talking teddy bear is made by a company in Taiwan. When a child presses Teddy's hand, the bear begins to talk. A built-in barometer selects one of five responses that predict the weather conditions. The responses range from "It looks to be a very nice day! Have fun" to "I think it may rain today. Don't forget your umbrella." Tests with the product show that, even though it is not a perfect weather predictor, its predictions are surprisingly good. Several of Specialty's managers claimed Teddy gave predictions of the weather that were as good as many local television weather forecasters. As with other products, Specialty faces the decision of how many Weather Teddy units to order for the coming holiday season. Members of the management team suggested order quantities of 15,000, 18,000, 24,000, or 28,000 units. The wide range of order quantities suggested indicates considerable disagreement concerning the market potential. The product management team asks you for an analysis of the stock-out probabilities for various order quantities, an estimate of the profit potential, and to help make an order quantity recommendation. Specialty expects to sell Weather Teddy for $24 based on a cost of $16 per unit. If inventory remains after the holiday season, Specialty will sell all surplus inventory for $5 per unit. After reviewing the sales history of similar products, Specialty's senior sales forecaster predicted an expected demand of 20,000 units with a .95 probability that demand would be between 10,000 units and 30,000 units. Managerial Report Prepare a managerial report that addresses the following issues and recommends an order quantity for the Weather Teddy product. Use R programming to obtain the solution. 1. Use the sales forecaster's prediction to describe a normal probability distribution that can be used to approximate the demand distribution. Sketch the distribution and show its mean and standard deviation. 2. Compute the probability of a stock-out for the order quantities suggested by members of the management team. 3. Compute the projected profit for the order quantities suggested by the management team under three scenarios: worst case in which sales 10,000 units, most likely case in which sales 20,000 units, and best case in which sales 30,000 units. (Case Problem from "Statistics for Business and Economics" –Anderson, Sweeney, and Williams Adapted for Classroom Discussion)

Problem Statement:

Speciality In decided to introduce a new toy called Weather Teddy and target the preholiday season so that they can make good business. Members of the Speciality Inc Management have to take the decision on how many units of new toy must be purchased to meet the anticipated sales demand.

Members of the Management suggested to order 15000, 18000, 24000, 28000 units. Since there is no consensus on the order quantity

a. Analyse the stock-out probabilities for various order quantities.

b. Sketch the demand distribution which follows the normal distribution and label the mean and standard deviation

c. Compute the probability of stock-out for the order quantities suggested.

d. Compute the projected profits for order quantities suggested under three scenarios

   i. Worst case in which the sales is 10000 units

   ii. Most likely case in which the sales is 20000 units

   iii. Best case in which the sales is 30000 units

Information in the case study :

a. Suggested order quantities are 15000 , 18000 , 24000 , 28000

b. The cost price of the Teddy is $16/unit

c. The Selling price of the Teddy is $24/unit (for the inventory available during the holiday season)

d. The Selling price of the Teddy is $5/unit (for the inventory available left out after the holiday season)

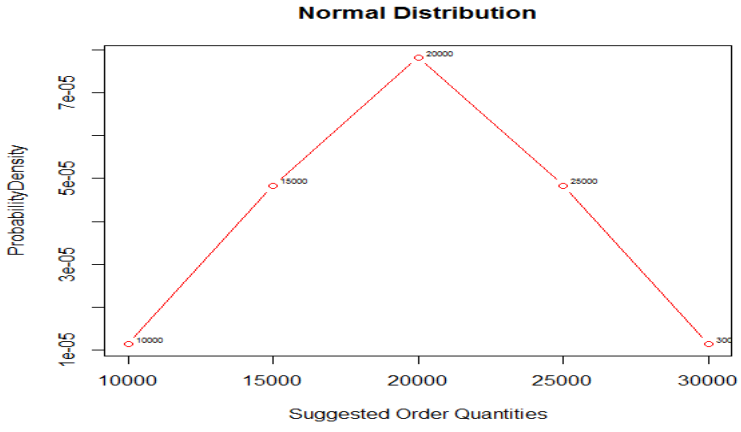
e. The Expected Demand is 20000 units with a probability fo 0.95 and the demand would range between 10000 and 30000.

Computations & Results :

a. The mean (μ) of the suggested ordered quantities is **20000** units.

b. Standard Deviation (σ) of the distribution is **5102.13.**

c. The sketch of distribution is as follows.



d. The suggested stocks and the corresponding probabilities that it would stock-out is as follows

Suggested Stock Order Quantity	Probability of Stock-Out
15000 units	**0.84**
18000 units	**0.65**
24000 units	**0.22**
28000 units	**0.06**

e. The following is the Profits in the worst, most likely and best case situations.

Suggested Order Quantity	Worst Case (10000 Units)	Most Likely (20000 Units)	Best Case (30000 Units)
15000 Units	$25000	$120000	$120000
18000 Units	-$8000	$144000	$144000
24000 Units	-$74000	$116000	$192000
28000 Units	-$118000	$72000	$224000

Analysis:

a. The mean of the distribution is 20000

b. The standard deviation is 5102 which means that the values of the ordered quantities deviates about 5102 on an average from mean.

c. The probabilities of stock-out for each of the suggested stock is indicated in above tables. Since the probability of stock-out in case the management ordered 28000 units is least value, the management must go with ordering 28000. This will ensure that they most probably do not run into the stock-out scenario. Thereby they can make best use of the preholiday seasonal demand.

d. If the management goes with ordering 28000 units , in most likely case, they would make the profit of $72000 and in best case they can achieve maximum profit of $224000 in the season.

R Program - Code

```
library(calibrate)

orderquantities = c(10000,15000,20000,25000,30000)

#Mean Computation

orderquantities_mean = mean(orderquantities)

print(paste("MEAN of Ordered Quantities <Mu>:" ,orderquantities_mean))
```

```
#Probability is given as 95% for the sales between 10K and 30K

zvalue = qnorm(1-(1-0.95)/2)

orderquantities_sd = round(10000/zvalue,2)

print(paste("STANDARD DEVIATION of Ordered Quantities <Sigma>:" ,orderquantities_sd))


#Plotting the Density

densityfuntion = dnorm(orderquantities,orderquantities_mean,orderquantities_sd)

plot(orderquantities, densityfuntion, col="red", xlab="Suggested Order Quantities",
ylab="ProbabilityDensity", type = "b" , main="Normal Distribution",lwd=1)

textxy(orderquantities, densityfuntion,orderquantities)

#Computing the Probability of out of stock situation.

print( paste("Suggested Stock | Probability"))

xseq_suggestedstock = c(15000,18000,24000,28000)

for(suggestedstock in xseq_suggestedstock) {

if(suggestedstock < orderquantities_mean) {

  probability = round(pnorm(abs((suggestedstock-orderquantities_mean)/StandardDeviation)),2)

}

else {

  probability = round(1-pnorm((suggestedstock-orderquantities_mean)/StandardDeviation),2)

}

  print( paste(suggestedstock,"|", probability))

}


#Profit Calculation

InitialProfit = 24 - 16

LaterProfit = 5-16

WorstCaseStockSold = 10000

MostLikelyStockSold = 20000
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```
BestCaseStockSold = 30000

print("SuggestedStock | WorstCaseStockSold -> TotalProfitInWorstCase | MostLikelyStockSold -> TotalProfitInMostLikelyCase | BestCaseStockSold -> TotalProfitInBestCase ")

xseq_orderedstock = c(15000,18000,24000,28000)

for(orderedstock in xseq_orderedstock) {

  if(orderedstock < WorstCaseStockSold) {

    TotalProfitInWorstCase = orderedstock * InitialProfit

  } else {

    TotalProfitInWorstCase = (WorstCaseStockSold * InitialProfit) + ((orderedstock-WorstCaseStockSold) * LaterProfit)

  }


  if(orderedstock < MostLikelyStockSold) {

    TotalProfitInMostLikelyCase = orderedstock * InitialProfit

  } else {

    TotalProfitInMostLikelyCase = (MostLikelyStockSold * InitialProfit) + ((orderedstock-MostLikelyStockSold) * LaterProfit)

  }


  if(orderedstock < BestCaseStockSold) {

    TotalProfitInBestCase = orderedstock * InitialProfit

  } else {

    TotalProfitInBestCase = (BestCaseStockSold * InitialProfit) + ((orderedstock-BestCaseStockSold) * LaterProfit)

  }

  print( paste(orderedstock,"|",WorstCaseStockSold,"-> $",TotalProfitInWorstCase,"|",MostLikelyStockSold,"-> $",TotalProfitInMostLikelyCase,"|",BestCaseStockSold,"-> $",TotalProfitInBestCase))

}
```