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Assessment of Reliability Factors in Chocolate Manufacturing Plant using Boolean Function Technique and Neural Networking.

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Abstract: ***A simple approach of solving a mathematical model depicting the reliability of a system is by doing its mathematical formulation using Boolean algebra technique and neural networking approach in simplication of complex system. Various reliability parameters are computed on applying Boolean and neural network approach. The author focus in this paper is to calculate the cost and factors of reliability of chocolate manufacturing plant using feed forward neural network approach using MATLAB.***

Keyword : Cost factor, Exponential distribution, Feed forward network, Neural Network, Neural weights, Reliability modeling, Weibull distribution.

I. INTRODUCTION

Earlier in reliability analysis of the system the various measures of the system effectiveness obtained were considered as precise value but practically there is some uncertainty in data either due to human error or due to the data is recorded. Further complexity of system escalates the degradation of functioning of system. The primary objective of reliability analysis is to predict the future life of the system by analyzing present functioning of the system. Different repair strategies undertaken, affects the system reliability in various ways. The social control of system confide on the judgement taken throughout coming up with, implementing in operation and maintaining. Several researcher studied the price and liableness of system earlier[3,4,5,7]. For complex system, it is tedious to solve the mathematical equations using the traditional approach. To tackle such problems, various soft computing methods like fuzzy logic etc. have been used earlier[7]. N. Karunanithi, D. Whitley [8] explain the concept of neural network in reliability. Ekta ,Neeraj gupta[9] apply neural network to find reliability of marine vehicle. Biological neuron system can be simplified to neural networks.

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We can recognize a neural network by three of its component such as neuron, network architectutre and learning algorithm. We can non linearly transform a multi dimensional input variable into multidimensional output variable using feed forward neural network architecture. There are three main parts of such transformation:
1) The input layer, it is the first part and communicates with environment.
2) The hidden layer, it is the enter mediatory layer.
3) Output layer, it gives the results to the user.
These layers are connected through links with weights
The process of adjusting these weights to minimize the error is discussed in learning algorithm. The complexity of the system can be reduced using the method as these network automatically recognize the relationship between data. Therefore it is very useful for modeling keeping these facts in mind, the model for chocolate manufacturing plant is studied by author.

II. SYSTEM DISCRIPTION

The production of chocolate involves various steps and hence each of which has related process factors which influence the productivity of the procedure and the various characteristics associated to the chocolate.
Selection of cocoa beans:- The randomly selected beans are analysed by the method accepted by the international standards organisation and the samples go cut tests.
Fermentation :-They are either put in substantially shallow, warmed plate or covered with expansive banana leaves.
Drying :-The drying process usually results in seeds that are about half of their original weight.
Roasting :-The shells of the beans is removed, and the inward cocoa bean meat is converted into little pieces called "cocoa nibs."
Winnowing: - The cooking procedure makes the covering of the cocoa seeds very weak, and cocoa nibs are made to go through a progression of sieves, which strain and sort the nibs as per measure.
Grinding :-By this procedure of grinding those nibs of cocoa are transformed into “cocoa alcohol" or “cocoa liquor”.
Pressing :-cocoa butter is extracted by cocoa mass.
Milling:- using milling cutter the material is removed from the surface of work station.
Mixing :-To enhance the flavour and the texture, through mixing is carried out..

Coaching:- the mixing, agitating, and aerating of liquid chocolate is done using this process.

The chocolate manufacturing plant under consideration here consist of 17 subsystems. Subsystem μ_1 consists of selected cocoa beans which are in standby i.e. when the main unit "μ_1" is in action, the standby unit "μ_2" forced into operation ,further the processes are carried out in the subsystems μ_3, μ_4, μ_5 an μ_6 that are drying, cleaning, roasting and winnowing respectively. After this process of grinding of the cocoa beans takes place in the subsystem $\mu_{7.}$ At the subsystem μ_7 we have the choice of converting the beans into cocoa powder through the processes of milling and sieving carried out by subsystems μ_9 and μ_{10} respectively or we can carry out the further process of extracting the fine chocolate through the manufacturing plant. In this case after the grinding of cocoa beans in subsystem μ_7 the cocoa nibs are converted to cocoa butter in the subsystem $\mu_{12.}$ The cocoa butter is mixed with milk in subsystem μ_{13} or grinded once more without milk in the subsystem μ_{14}. After this the grounded cocoa butter is perfectly conched in the subsystem μ_{15}. Furthermore, the resulting solid chocolate is enrobed into thin layers in the subsystem μ_{16}. Finally the panning is done to give the product shiny finishing the subsystem μ_{17}.

SECTION 1

In this section we apply Boolean technique to evaluate reliability and M.T.T.F.

III. ASSUMPTIONS

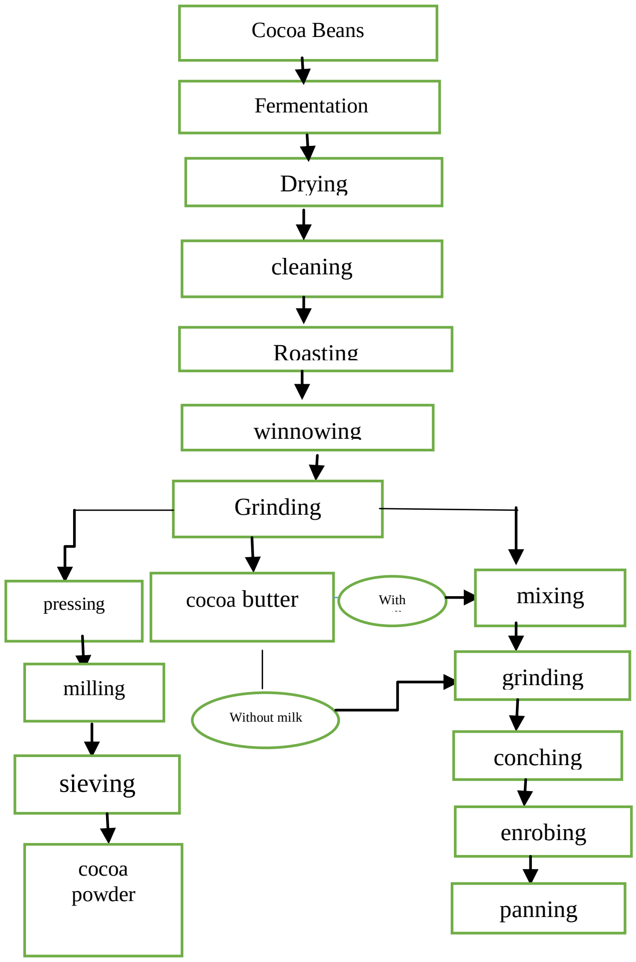
- In starting all units are fully operable.
- The component of all states is either operable or partially operable.
- No repair facility is provided.
- System conditions individually are statistically independent..
- In advance we know all component reliability.
- All components follow arbitrary failure time.
- The element which provide supply between two components considerd as fully reliable.

IV. NOTATIONS USED

μ_1= selection of cocoa beans
μ_2= fermentation
μ_3= drying
μ_4= cleaning
μ_5= roasting
μ_6= winnowing
μ_7= grinding
μ_8= pressing
μ_9= milling
μ_{10}= sieving
μ_{11}= cocoa powder
μ_{12}= cocoa butter
μ_{13}= mixing
μ_{14}= grinding
μ_{15}= couching
μ_{16}= enrobing
μ_{17}= panning
| |: symbol of logical matrix.

G_i: i^{th} part system reliability
For all i = 1,2,..17.
G_s: whole system reliability.
G_{SW}: Reliability when it follows weibull distribution.
G_{SE}: Reliability when failure rate follows exponential distribution.

V. MATHEMATICAL MODEL



VI. FORMULATION OF MATHEMATICAL MODEL

After applying technique of Boolean function the chances of successfully operation of system are expressed in logical matrix.

$F(\mu_1, \mu_2 \dots \mu_{17})$ =

$$\left| \begin{array}{llllllllllllll} \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_8 & \mu_{12} & \mu_{13} & \mu_{14} & \mu_{15} & \mu_{16} & \mu_{17} \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_8 & \mu_{12} & \mu_{14} & \mu_{15} & \mu_{16} & \mu_{17} & \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_{12} & \mu_{13} & \mu_{14} & \mu_{15} & \mu_{16} & \mu_{17} & \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_{12} & \mu_{14} & \mu_{15} & \mu_{16} & \mu_{17} & & \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_{13} & \mu_{14} & \mu_{15} & \mu_{16} & \mu_{17} & & \\ \mu_1 & \mu_2 & \mu_3 & \mu_4 & \mu_5 & \mu_6 & \mu_7 & \mu_8 & \mu_9 & \mu_{10} & \mu_{11} & & & \end{array} \right|$$

………(1)

VII. MODEL SOLUTION

On writing equation (1) after applying algebra of logics as follows:
By using algebra of logics, we write equation (1) again as follows

$$F(\mu_1,\mu_2,\ldots,\mu_{17}) = |(\mu_1\ \mu_2\ \mu_3\ \mu_4\ \mu_5\ \mu_6\ \mu_7) \wedge \delta(\mu_1\ \mu_2\ \mu_3\ \mu_4\ \mu_5\ \mu_6,\ldots\mu_{17})| \quad \ldots\ldots(2)$$

Where

$$\delta(\mu_1, \mu_2, .., \mu_{17}) = \left|\begin{matrix} \mu_8\ \mu_{12}\ \mu_{13}\ \mu_{14}\ \mu_{15}\ \mu_{16}\ \mu_{17} \\ \mu_8\ \mu_{12}\ \mu_{14}\ \mu_{15}\ \mu_{16}\ \mu_{17} \\ \mu_{12}\ \mu_{13}\ \mu_{14}\ \mu_{15}\ \mu_{16}\ \mu_{17} \\ \mu_{12}\ \mu_{14}\ \mu_{15}\ \mu_{16}\ \mu_{17} \\ \mu_{13}\ \mu_{14}\ \mu_{15}\ \mu_{16}\ \mu_{17} \\ \mu_8\ \mu_9\ \mu_{10}\ \mu_{11} \end{matrix}\right| = \left|\begin{matrix} M_1 \\ M_2 \\ M_3 \\ M_4 \\ M_5 \\ M_6 \end{matrix}\right| \quad \ldots\ldots\ldots\ldots(3)$$

By using the method of orthogonalization we write algorithm (3) as

$$\delta(\mu_1, \mu_2, \ldots, \mu_{17}) = \left|\begin{matrix} M_1' \\ M_1' M_2 \\ M_1' M_2' M_3 \\ M_1' M_2' M_3' M_4 \\ M_1' M_2' M_3' M_4' M_5 \\ M_1' M_2' M_3' M_4' M_5' M_6 \end{matrix}\right| \quad \ldots..(4)$$

On solving algorithm (4)

VIII. RESULT AND DISCUSSION

If the reliability be G and the unreliability be H then the reliability of the whole system is given by :

CASE I: If G is each Component Reliability then Algorithm (4) given as

$$G_s = -G^{10} + 3G^9 - 4G^8 + G^7 - G^6 + 2G^5 + G^4 \quad \ldots\ldots.(5)$$

CASE II : WHEN THE FAILURE RATE FOLLOWS WEIBULL TIME DISTRIBUTION.

If failure rate is Υ_i for section state x_i , for all i=1,2,…….17 then chocolate manufacturing plant reliability at an instant 'x' is given by:

When u=0.01 and x= 0,1,2,3,4,5…….. numerical results obtained to study effect of various reliability parameters for the steady state of the system.if the parameters like failure rate and repair rate are altered the reliability of the system is affected.

$$G_{sw}(x) = \sum_{i=1}^{32} \exp\{-\omega_i x\} - \sum_{j=1}^{31} \exp\{-\phi_j x\}$$

$$G_{sw}(x) = \exp(-4ux^s) + 2\exp(-5ux^s) - \exp(-6ux^s) + \exp(-7ux^s) - 4\exp(-8ux^s) + 3\exp(-9ux^s) - \exp(-10ux^s)$$

$$= e^{-8ux} + 2e^{-10ux} - e^{-12ux} + e^{-114ux} - 4e^{-16ux} + 3e^{-18ux} - e^{-20ux}$$

where, s is +ve and ω and ϕ are as follows :

$\omega_1 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_2 = \Upsilon_8\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_3 = \Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_4 = \Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_5 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_6 = \Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_7 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_8 = \Upsilon_8\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_9 = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}$
$\omega_{10} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}$
$\omega_{11} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}$
$\omega_{12} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\omega_{13} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}$
$\omega_{14} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\omega_{15} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\omega_{16} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\omega_{17} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\omega_{18} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\omega_{19} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{17}$
$\omega_{20} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_{21} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}$
$\omega_{22} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}$
$\omega_{23} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}$
$\omega_{24} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\omega_{25} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}$
$\omega_{26} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\omega_{27} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\omega_{28} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\omega_{29} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}$
$\omega_{30} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\omega_{31} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\omega_{32} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$

and

$\phi_1 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_2 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_3 = \Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_4 = \Upsilon_8\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_5 = \Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_6 = \Upsilon_8\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_7 = \Upsilon_8\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_8 = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}$
$\phi_9 = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}$
$\phi_{10} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}$
$\phi_{11} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}$
$\phi_{12} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\phi_{13} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\phi_{14} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\phi_{15} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\phi_{16} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\phi_{17} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\phi_{18} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{17}$
$\phi_{19} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_{20} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}$
$\phi_{21} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\phi_{22} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\phi_{23} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}$
$\phi_{24} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$
$\phi_{25} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\phi_{26} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$
$\phi_{27} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$
$\phi_{28} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}$
$\phi_{29} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}$

$\phi_{30} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}$

$\phi_{31} = \Upsilon_8\Upsilon_9\Upsilon_{10}\Upsilon_{11}\Upsilon_{12}\Upsilon_{13}\Upsilon_{14}\Upsilon_{15}\Upsilon_{16}\Upsilon_{17}$

Table- I: Reliability under Weibull distribution

U	X	$G_{SW}(x)$
0.01	0	1
0.01	1	0.9937337
0.01	2	0.9768739
0.01	3	0.9519343
0.01	4	0.9209729
0.01	5	0.8856687
0.01	6	0.8473857
0.01	7	0.8072261
0.01	8	0.7660748
0.01	9	0.7246362

CASE III :WHEN FAILURE RATE FOLLOWS EXPONENTIAL DISTRIBUTION.

At an instant 's' the whole system reliability is expressed as $G_{SE}(x) = \sum_{i=1}^{32} \exp\{-\omega_i x\} - \sum_{j=1}^{31} \exp\{-\phi_j x\}$

$G_{SE}(x) = \exp(-4ux^s)+2\exp(-5ux^s)-\exp(-6ux^s)+\exp(-7ux^s)-4\exp(-8ux^s)+3\exp(-9ux^s)-\exp(-10ux^s)$

$= e^{-4ux}+2e^{-5ux}-e^{-6ux}+e^{-7ux}-4e^{-8ux}+3e^{-9ux}-e^{-10ux}$

Table – II: Reliability under exponential distribution

U	X	$G_{SE}(x)$
0.01	0	1
0.01	1	0.9983683
0.01	2	0.9937337
0.01	3	0.9348090
0.01	4	0.9768739
0.01	5	0.9652757
0.01	6	0.9519343
0.01	7	0.9370933
0.01	8	0.9209729
0.01	9	0.9037716

Table –III: Comparison of reliability in exponential and Weibull distribution:

x	$G_{SW}(x)$	$G_{SE}(x)$
0	1	1
1	0.9937337	0.9983683
2	0.9768739	0.9937337
3	0.9519343	0.9864592
4	0.9209729	0.9768739
5	0.8856687	0.9652757
6	0.8473857	0.9519343
7	0.8072261	0.9370933
8	0.7660748	0.9209729
9	0.7246362	0.9037716

The mean time to failure(M.T.T.F) is obtained as

M.T.T.F. $= \int_0^\infty G_{SE}(x)dx$

$= \int_0^\infty e^{-\omega ix}dx - \int_0^\infty e^{-\phi jx}dx$

$= \sum_{i=1}^{32}\left(\frac{1}{\omega i}\right) - \sum_{j=1}^{31}\left(\frac{1}{\phi j}\right) = \frac{13}{60u}$

Table- IV: MTTF vs Failure rate

U	M.T.T.F
0	∞
0.01	26.66666
0.02	10.83333
0.03	7.222222
0.04	5.416666
0.05	4.333333
0.06	3.611111
0.07	3.095238
0.08	2.708333
0.09	2.407407
0.1	2.166666

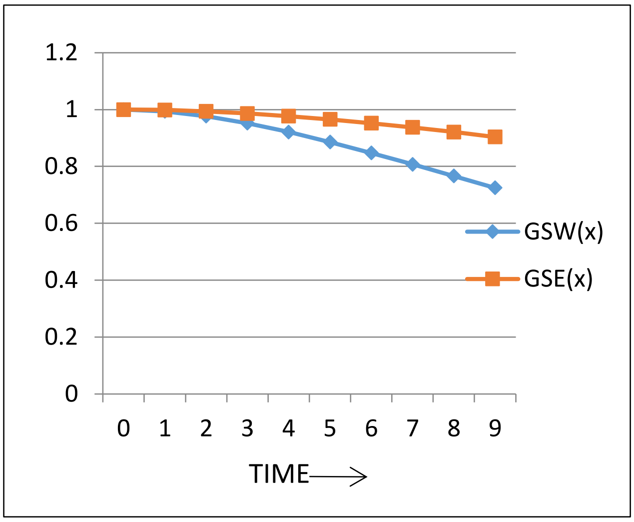


Figure 1. Comparison of reliability in different distribution with respect to time

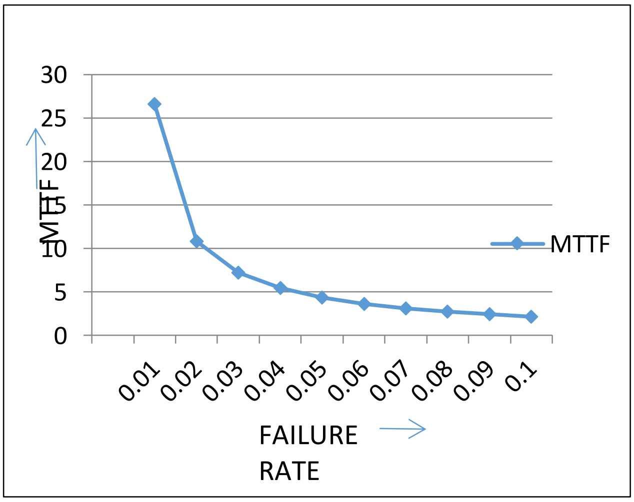


Figure: 2 MTTF vs Failure rate

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SECTION II
NEURAL NETWORK APPROACHES FOR ANALYTICAL OF CHOCOLATE MANUFACTURING PLANT.

In figure 3 the working of choclate manufacturing system is discussed. The accurate estimation of different reliability measures can help in decision making and chance the future performance of the system. Design deficiencies unavoidable complexities may result in increasing unreliability of system. Failure rate has major significance in reliability analysis. For neural network approach, the failure rates and repair rates are taken as neural weights. Back propagation algorithm is used to determine the weights of neural network. The reliability is obtained by repeating the process of determining and adjusting the weights. Using Feed Forward algorithm, MATLAB program is developed to find various measures of reliability

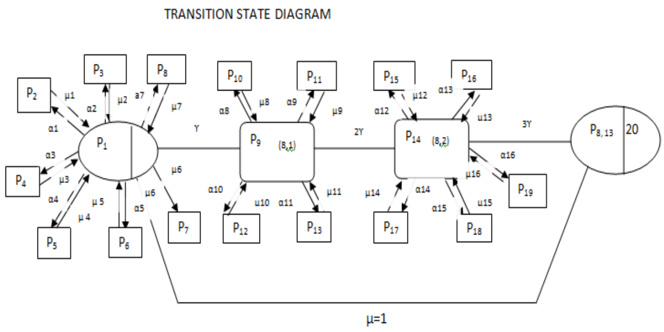

Figure 3.

EQUATIONS

The basic equations of neural network are represented in the following:

$Y_i = P_i(t+\Delta t)$; where i= 1, 2, 3, . . . ,20.

$Y_1 = \omega_{11}X_1 + \omega_{11}X_1 + \omega_{21}X_2 + \omega_{31}X_3 + \omega_{41}X_4 + \omega_{51}X_5 + \omega_{61}X_6 + \omega_{71}X_7 + \omega_{81}X_8 + \omega_{20,1}X_{20}$.

$Y_2 = \omega_{12}X_1 + \omega_{22}X_2$

$Y_3 = \omega_{13}X_1 + \omega_{33}X_3$

$Y_4 = \omega_{14}X_1 + \omega_{44}X_4$

$Y_5 = \omega_{15}X_1 + \omega_{55}X_5$

$Y_6 = \omega_{16}X_1 + \omega_{66}X_6$

$Y_7 = \omega_{17}X_1 + \omega_{77}X_7$

$Y_8 = \omega_{18}X_1 + \omega_{88}X_8$

$Y_9 = \omega_{10,9} X_9 + \omega_{11,9}X_{11} + \omega_{12,9}X_{12} + \omega_{13,9}X_{13}$

$Y_{10} = \omega_{9,10} X_9 + \omega_{10,10}X_{10}$

$Y_{11} = \omega_{9,11} X_9 + \omega_{11}X_{11}$

$Y_{12} = \omega_{9,12} X_9 + \omega_{12,12}X_{12}$

$Y_{13} = \omega_{9,13} X_1 + \omega_{13,13}X_{13}$

$Y_{14} = \omega_{15,14}X_{14} + \omega_{16,14}X_{16} + \omega_{12}X_1 + \omega_{17,14}X_{17} + \omega_{18,14}X_{18} + \omega_{19,14}X_{19} + \omega_{20,14}X_{20}$

$Y_{15} = \omega_{14,15}X_{15} + \omega_{15,15}X_{15}$

$Y_{16} = \omega_{14}X_{16} + \omega_{16,16}X_{16}$

$Y_{17} = \omega_{14,17}X_{17} + \omega_{17,17}X_{17}$

$Y_{18} = \omega_{14,18}X_{18} + \omega_{18,18}X_{18}$

$Y_{19} = \omega_{14,19}X_{19} + \omega_{19,19}X_{19}$

$Y_{20} = \omega_{14,20}X_{20} + \omega_{20,20}X_{20}$

IX. EXPERIENT RESULTS

The proposed method has been tested on the data obtained from chocolate manufacturing system.

System uptime (according to the state transition diagram):

$P_{uptime} = Y_{18} + Y_9 + Y_{14}$.

$P_{downtime}(t) = Y_2 + Y_3 + Y_4 + Y_5 + Y_6 + Y_7 + Y_8 + Y_{10} + Y_{11} + Y_{12} + Y_{13} + Y_{15} + Y_{16} + Y_{17} + Y_{18} + Y_{19} + Y_{20}$.

$= 0.955x_1 + 0.1x_2 + 0.1x_3 + 0.1x_4 + 0.1x_5 + 0.1x_6 + 0.1x_7 + 0.1x_{20} + 0.1x_9 + 0.1x_{11} + 0.1x_{12} + 0.1x_{13} + 0.1x_{14} + 0.1x_{16} + 0.1x_{17} + 0.1x_{18} + 0.1x_{19} + 0.1x_{20}$

$P_{uptime}(t) = e^{-at} - \Lambda c_1/(a-b)\, e^{-at} + \Lambda c_1/(a-b)\, e^{-bt}$

It is interesting to note that $P_{uptime}(t) = 1$. (tending to 1)

If the number of iterations are more than better result can be obtained. This results shows that how reliability is affected when time diversifies. In addition to this we calculate cost analysis of the system with time using following equation..

Profit function $G(t) = \int_0^t Pup\,(t) - C2t - C3$.

Where, C1 = revenue cost, C2 = repair cost per unit time and C3 = establishment cost of system.

Table – V: Comparative cost with respect to time

t	C1	C2	C3
0	1000	0	0
0.01	2000	200	100
0.02	3000	100	100
0.03	4000	200	100
0.04	5000	100	100
0.05	6000	100	100
0.06	6000	200	100
0.07	6000	200	100
0.08	6000	200	100
0.09	6000	200	100
0.1	6000	200	100

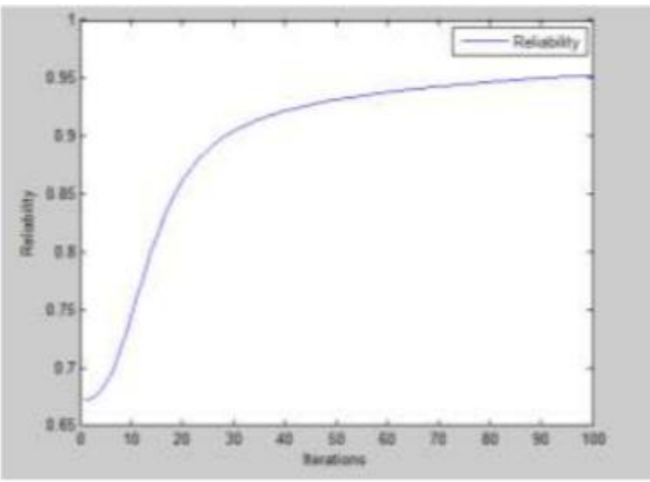

Figure 4: time vs reliability

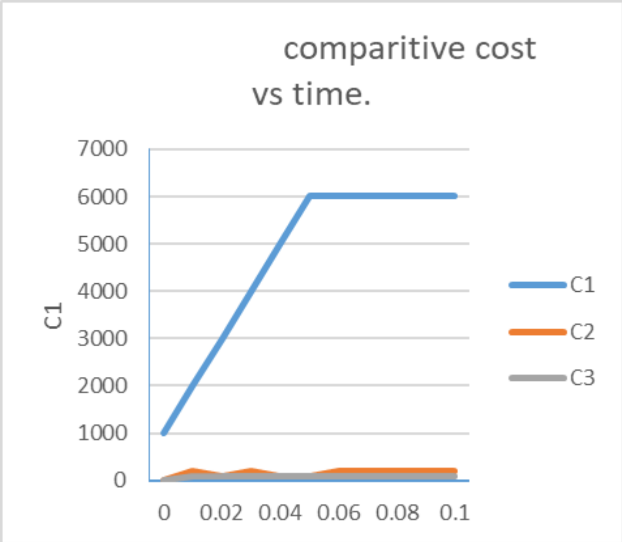

Figure:5 cost analysis vs time

X. CONCLUSIONS

In this paper to calculate reliability, we discussed two different approaches neural network approach and Boolean approach for chocolate manufacturing plant. Critical observations of the tables and respected graphs reveal that reliability of the system for finite interval of time is much higher, but after a sufficient long interval of time it is reduced; while mean time to system failure fails gradually. We considered the graph of reliability with time using two different techniques. System profit in long time shown in figure 5.which will be a great help to economist. To evaluate various reliability factors technique of Neural is very useful. Our Role to evaluate reliability using both techniques is just an little step to find out such important technological field. It is hoped that this contribution can use as a vital resource for contemporary time applications.

REFERENCES

1. K.Muralidharan, A.Syamsundar. Statistical Methods for Quality, Reliability and Maintainability. PHI Learning pvt. Ltd.,2012.
2. Gupta P.P., Agarwal S.C., A Boolean Algebra Method For reliability Calculations (Published work style). Microelectronic Reliability, Vol.23.U.K. l983. pp. 863-865.
3. S.C.Agarwal, Mamta Sahani & Shikha Bansal." reliability characteristic of cold-standby redundant system" IJRRAS 3 (2) May 2010
4. L. Britler Alan, Crystal D. Sloan, „System reliability Prediction: Towards a general approach using neural network",Nashville,Tennessee, American Institute of Aeronautics and Astronautics, 2005.
5. Ronald E. Giutini, „Mathematical characterization of human reliability for multitask system operations", IEEE, pp 1325-39, 2000.
6. Igor Bazovsky, Reliability theory and practice, PHI Englewood cliff, NJ, 1961.
7. Dillon BS. Reliability Quality and Safety Engineers (Book style). Taylor Francis, U.K., 2004.
8. Rajasekaran, S., Pai, G.A. Vijaylakshmi, Neural Networks, Fuzzy Logic, and Genetic Algorithms, PHI, 2004
9. N. Karunanithi, D. Whitley, Y. K. Malaiya, 'Using neural networks in reliability', IEEE, Vol. 9, pp 53-59, Jul 1992.
10. Ekata, Neeraj Gupta and S.B. Singh, "Operational availability of marine vehicle system using neural network approach", IJCSM, vol. 2, pp. 91-99, 2010
11. K.W. Chau, "Reliability and performance-based design by artificial neural network", Elsevier, Science direct, Advances in Engineering Software 38, pp 145-149, 2007.

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