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A Model for Taking Decision for Rejuvenation of Machine Tools

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Abstract

The replacement of the facilities with the new one may be an expensive proposition. The Renovation/Modernization has been found to be efficient answer to reinforce the performance by retrofitting of state-of-the- technology and provides a new lease of the life to the facilities. It's been tried to explain the efficient high-tech solutions to Renovate/Upgrade the present facilities

Keywords: Retrofitting; Upgradation; Maintenance; Automation

Introduction

CNC system refers to the automation of machine tools that are operated by abstractly programmed commands encoded on storage medium, as opposed to manually controlled. In Manufacturing sectors like power equipment manufacturing, automobiles, process industry etc. CNC System based machines are used for various cutting applications like drilling, milling, turning, boring, punching, notching and for special purposes like winding, pressing, taping etc. Due to the ageing of the machine, technological obsolescence, reduced accuracy, increased number of breakdown make it necessary to think for the Retrofitting/Reconditioning/Upgradation of the machine, but there is no widely accepted model for the estimation of cost of Retrofitting/Reconditioning/Upgradation

Existing Literature Efforts

Prakash et al., [1] reported that now a days, products can be produced by smart technology, that uses laptop code, hardware and firm ware in industries. It's required to use CNC lathe machine to urge a lot of correct dimensions and irregular shape. So, CNC machines are getting important in modernized industrial enterprise. There are several standard lathe machines in our country to create a new modern developed country, it's needed to convert these standard lathe machines into semi-automatic control lathe machine by retrofitting. Developing and becoming semi-automatic control lathe machine, there are three needed parts, namely, mechanical, hydraulic and electronics during this project we have a tendency to convert the convention lathe that have 5 ft bed length in to the semi-automatic lathe. In mechanical side we replace the ball screw in place of lead screw for better accuracy and remove some unnecessary component like gears for providing space for motors. We add an extra plates or structure for installation of motors. Also provides a hydraulic circuit for coolant. In electronic side we used a servo/stepper motor for both Z and X axis and provide controller for the efficient operation.

By developing automation in typical lathe machine by retrofitting stepper based methodology, the machine works as a CNC trainer for teaching and learning. The price of machine is minimizes approximate four times below the initial CNC trainer. A standard lathe machine is automated/retrofitted by exchange or removing the elements/parts. Setup price is high as compare with normal lathe machine however production rate high, thus it is helpful for production.

The accuracy of the job made by retrofitted lathe machine is high thus repeatability and dimensional stability of the job is achieved. Finally some complicated job that cannot be achieved by typical lathe machine can be achieved by newly developed retrofitted lathe machine.

Gontarz et al., [2] reported that the analysis of activities of nowadays not solely try to address the legislative pressure given by the Directive of the European Parliament on Energy using products however conjointly aim for economic blessings for the machine user by work and applying appropriate procedures and strategies that facilitate to model, forecast, and cut back the energy and resource consumption. The common goal is to cut back the number of resources consumed and increase machine potency with the assistance of selective strategies and a very least investment. An approach to identify on top of mentioned benefits is given on the presented analysis work and paper. This paper introduces a technique for investigation and shaping cheap investments for retrofit solutions and optimization methods counting on the particular conditions, an approach for the effective acquisition of the desired information, and therefore the strategy won't to sight optimization potentials supported these findings.

The analysis evaluates retrofit activities below the surface to cut back energy consumption might be found supported machine measurements. It's primarily addressed to the auxiliary however may even be extended to method connected elements. Measurements on the machine level are necessary on condition that instrumental data cannot be withdrawn from the management. It's thus necessary to interpret the measurements accurately. For acceptable information data, methodologies and calculations from alternative analysis fields are often adopted. Starting with the general machine activity, this technique evaluates the energetic behavior and share of every machine element. The central purpose is drawn by the time at level numeration. This calculation detects the mode of operation of every element. This methodology likewise allows the machine builder within the future machine style and machine users to boost machines within the field any analysis should be done to work out at that spots and degree retrofit might be applied, mainly considering economic necessities, e.g. come back on investment. Acceptable retrofit choices are required in commission and maintenance applications. As the best owed methodology depends on a transparent input, the effective power activity and corresponding elements, it's thought of a fast and powerful

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assessment tool and serves moreover as a base for any analysis.

Bhupendra Mishra [3] reported that the main purpose is to predict the Retrofitting/Reconditioning/Upgradation price of used CNC Machines in producing industries therefore to optimize the capital investments on these activities. The tool neural network may be used to predict these prices, as there's no better-known relationship between the price below consideration and also the factors to blame for the Retrofitting/Reconditioning/Upgradation. Though few replacement model supported depreciation worth of the CNC Machine, still this model fails to report the result of technological degeneration, mechanical condition of the machine and also the substantial modification within the production technology and valid just for the capital retirement, however ineffectual to see the Retrofitting/Reconditioning/Up-gradation comes and their cost accounting.

CNC system refers to the automation of machine tools that are operated by abstractly programmed commands encoded on data-storage medium, as opposition manually controlled. In producing sectors like power instrumentation producing, vehicles, method business etc. CNC System primarily based machines are used for numerous cutting applications like turning, boring, drilling, milling, notching, punching and for special functions like winding, pressing, taping etc. as a result of the ageing of the machine, technological devolution, reduced accuracy, increased number of breakdown build it necessary to assume for the Retrofitting/Reconditioning/Upgradation of the machine, however there's no wide accepted model for the estimation of value of Retrofitting/Reconditioning/Upgradation. Presently the cost accounting supported salvage price of the machine supported depreciation and alternative monetary factors however it utterly neglects the factors mechanical condition of the machine, technological devolution of the system, quantitative relation of calculable lifetime of the machine once retrofitting and lifetime of a brand new machine.

This paper seeks to work out whether or not correct prediction of value of Retrofitting/Reconditioning/Upgradation of CNC Machines may be developed using neural network. I found that the simplest neural network produces a Validation MSE of 3.861e-15, coaching MSE $\approx$ e-16, take a look at MSE $\approx$ e-4. With the reliable prediction of value, administrator will accurately decide the Retrofitting projects and their cost accounting. The Retrofitting value is calculated for the abstract information. If the mechanical condition of the machine isn't ok and also the age of the machine is greater than fifteen years then high value of retrofitting of the CNC machine into account is justified. If the machine is new i.e. age of the machine is a less than five years and availability of the Machine is a smaller than the expected then also going for the retrofitting isn't appropriate, if the value is greater than 100 % of the machine's value. Indicates the utmost retrofitting value that may be endowed on the machine. The accuracy of the prediction is probably going to originate from the flexibility of neural network to capture non-linear relationships. though the considerable MSE is determined within the trained neural network however totally different coaching algorithms could also be chosen like trainrp, traingda, traingdx, reduced memory trainlm etc. and performance in every may be compared and best may be chosen though the results are significantly supported the info for CNC machines, however it'll be fascinating to visualize the model for the Non-CNC Machines, artificial intelligence Machines, other special purpose machines and method plants utilized in Automobile sectors, power sectors, Sugar Industries etc. during this device forward network is employed for the modeling however it's fascinating to use the data samples to coach the perennial networks, or significantly the pattern recognition networks. In this paper solely settled activation functions (tansig, logsig, purelin) are used, it'll be fascinating to use the non-deterministic activation operate of the output layer.

Utkarsh et al., [4] reported that the Non-Homogeneous Poisson method (NHPP) with special attention on its application/use in maintenance decision–making. A sensible study from an outsized producing trade is taken to illustrate the utilization of this model. Failure information of a CNC horizontal boring machine is collected and analyzed. Cost analysis is done to come to a decision optimum maintenance policy for the machine. The results show that the model helps to analyze failure information effectively, and provides effective tool to administrator with reference to the maintenance policies and/or ways.

Most industrial systems are complicated serviceable. To predict the long run performance it's necessary to understand a way to model the failure knowledge of those systems and also the necessary assumptions of the form. These information are typically freelance and identically distributed generated by the restoration method of the component/system to attain optimum performance from the serviceable system the vital steps are to model the failure method, to explain the failure behavior of every element of the system, to watch the progress, to look at the long run output. This may facilitate to form once and what call, i.e. call for repair/replace the component/equipment of the system. With continuous repair and/or overhaul, the serviceable systems show continuous performance degradation is tough to analyze and model.

The MTBF of this element relies on likelihood distribution, that is taken into account on the premise of failure analysis techniques (where knowledge are recorded in magnitude with commonplace distribution not essentially appropriately fitted for these situation). For the event analysis there are two approaches:

(a) Non–homogeneous Poisson's method and

(b) Proportional hazard and its derivatives each have deserves and show sensible lead to failure analysis of serviceable systems. the current work can facilitate to develop a sensible analysis of the failure knowledge of CNC horizontal boring machine put in at asian nation significant Electricals Ltd (BHEL), Haridwar, India. The machine is especially used to manufacture the governing valve casing, emergency stop valve and management valve, recess valve and servo motor casing at the producing website.

It is concluded from the study that NHPP models the failure knowledge of CNC horizontal boring machine with special stress on semi permanent dependability degradation. The appliance and use of the model helps within the support of maintenance strategy optimization techniques. It additionally helps to model failure knowledge effectively and provides effective tool for deciding with relevance choice of maintenance policies the choices for the replacement are:

(i) Replace the machine either when nineteen years of use or

(ii) Replace the machine once 2468 range of failures are discovered.

Methodology

In order to make the decision making weather a machine should be retrofitted/maintained/buy a new machine, we introduce a model that calculates the profit for the coming 'n' year in following three cases

1. Retrofitting/Reconditioning/Upgradation profit function (RPF)

2. Maintenance profit function (MPF)
3. Buying new machine profit function (NMPF)

Then we go for the decision which has maximum profit function

Input variables that are used to calculate these profit functions are

1. Present asset value of the machine under study (x1)
2. Cost of the new machine (x2)
3. Maintenance cost of machine under study (x3)
4. Cost of Retrofitting/Reconditioning/Upgradation of the machine under study (x4)
5. Effect of technology on the capacity of new machine (x5)
6. Rate of production decay of the machine under study (x6)
7. Capacity of New Machine (x7)
8. Capacity of machine after Retrofitting/Reconditioning/Upgradation (x8)
9. Life of machine after Retrofitting/Reconditioning/Upgradation (in yrs)(x9)
10. Life of a new Machine (in yrs) (x10)
11. Rate of increase of Maintenance cost of machine under study (x11)
12. Maintenance cost after Retrofitting/Reconditioning/Upgradation (x12)
13. Rate of increase of Maintenance cost of machine after Retrofitting/Reconditioning/Upgradation (x13)
14. Capacity of machine under study (x14)
15. Salvage value of the machine under study (x15)
16. Maintenance cost of new machine(x16)
17. Rate of increase of Maintenance cost of new (x17)
18. Rate of Depreciation of Assets (xd)
19. Rate of taxation (x18)
20. Asset Value of Retrofitted Machine (x19)

Assumptions taken in the model

1. Fixed Depreciation is taken for asset valuation
2. Rate of increase of maintenance cost is assumed to be constant

Production by the machine for its good life assumed to be constant

In order to calculate the profit functions (MPF, RPF, NMPF) we will consider all factors as additive which are profitable and subtractive which are loss in financial terms, like Depreciations of a machine is a additive factor and the cost for the procurement of a new machine is a subtractive factor.

So in order to calculate the RPF we will consider all the additive factors and subtractive factors just like we do in the profit/ loss accounts.

RPF=ΔC_1- ΔD_1+ ΔM_1-ΔI_1

ΔC_1=capacity of machine if retrofitted for x9 years – capacity of machine for x9 years under study

ΔD_1=profit in Depreciation if retrofitted for x9 years – profit in Depreciation of machine for x9 years under study

ΔM_1=Maintenance cost of machine if retrofitted for x9 years – Maintenance cost of machine for x9 years under study

ΔI_1=Cost of retrofitting of machine – Salvage value of machine under study

Based on above factors RPF can be formulated as

$$RPF = x_9 x_8 - x_{14}\left(\frac{1-(1-x_6)^{x_{9+1}}}{x_6}\right) + x_1 x_{18}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right) - x_{19}x_{18}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right) - x_{12}\left(\frac{(1+x_{13})^{x_{9+1}}-1}{x_{13}}\right) + x_3\left(\frac{(1+x_{11})^{x_{9+1}}-1}{x_{11}}\right) - x_4 + x_{15}$$

MPF=ΔD_2- ΔC_2 - ΔM_1

ΔC_2=capacity of machine if retrofitted/new machine procured for x9 years – capacity of machine for x9 years under study

ΔD_2=- profit in Depreciation if retrofitted or a new machine is procured for x9 years + profit in Depreciation of machine for x9 years under study

M_2 =Maintenance cost of machine for x9 years under study

Based on above factors MPF can be formulated as

$$MPF = x_{14}\left(\frac{1-(1-x_6)^{x_{9+1}}}{x_6}\right) - x_1 x_{18}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right) - x_3\left(\frac{(1+x_{11})^{x_{9+1}}-1}{x_{11}}\right) + \max\left\{x_{19}x_{18}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right), x_2 x_{18}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right)\right\} - \max\left(x_8 x_9, x_7 x_9\right)$$

NMPF=ΔC_3- ΔD_3+ ΔM_3-ΔI_1

ΔC_3=capacity of new machine for x9 years – capacity of machine for x9 years under study

ΔD_3=profit in Depreciation of new machine for x9 years – profit in Depreciation of machine for x9 years under study

ΔM_3=Maintenance cost of new machine for x9 years – Maintenance cost of machine for x9 years under study

ΔI_3=Cost of new machine – Salvage value of machine under study

Based on above factors RPF can be formulated as

$$NMPF = x_{15} - x_2 + \mathbf{max}\left[x_{12}\left(\frac{(1+x_{13})^{x_{9+1}}-1}{x_{13}}\right) - x_{16}\left(\frac{(1+x_{17})^{x_{9+1}}-1}{x_{17}}\right), x_3\left(\frac{(1+x_{11})^{x_{9+1}}-1}{x_{11}}\right) - x_{16}\left(\frac{(1+x_{17})^{x_{9+1}}-1}{x_{17}}\right)\right] + \max\left(x_7\ x_9 - x_8 x_{10}, x_7 x_{10} - x_{14}\left(\frac{(1+x_6)^{x_{9+1}}-1}{x_6}\right)\right) + x_{18}x_{19}\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right) - x_{18}x_2\left(\frac{1-(1-x_d)^{x_{9+1}}}{x_d}\right)$$

Now we will go for a decision that will give maximum profit functions i.e. if for a machine we get RPF >MPF>NMPF then we will go for the retrofitting of the machine.

Case Study of Machines

Case studies of all the machines is based on CNC Lathe Machine in which some of the machines condition are very old and not able to give the maximum production and some of them are in good condition and the size of all the machines are medium.

Case study: 1

1. Present asset value of the machine under study. $x1=30(1-0.05)^{24}=10$ lacs

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2. Cost of the new machine (x2=700 lacs)
3. Maintenance cost of machine under study (x3=7 lacs/yr)
4. Cost of Retrofitting/ Reconditioning/Upgradation of the machine under study (x4=300 lacs)
5. Effect of technology on the capacity of new machine (x5)
6. Rate of production decay of the machine under study (x6=5%)
7. Capacity of New Machine (x7=100 lacs/yr)
8. Capacity of machine after Retrofitting/Reconditioning/ Upgradation (x8=95 lacs/yr)
9. Life of machine after Retrofitting/Reconditioning/Upgradation (in yrs)(x9=10 years)
10. Life of a new Machine (in yrs) (x10=20 years)
11. Rate of increase of Maintenance cost of machine under study (x11=25%)
12. Maintenance cost after Retrofitting/Reconditioning/ Upgradation (x12=3.5 lacs/yr)
13. Rate of increase of Maintenance cost of machine after Retrofitting/Reconditioning/Upgradation (x13=2%)
14. Capacity of machine under study (x14=12 lacs/yr)
15. Salvage value of the machine under study (x15=50 lacs)
16. Maintenance cost of new machine(x16=1 lac/yr)
17. Rate of increase of Maintenance cost of new (x17=1%)
18. Rate of Depreciation of Assets (x_d=5%)
19. Rate of taxation (x18=20%)
20. Asset Value of Retrofitted Machine (x19=80 lacs)

$$\boldsymbol{RPF} = 10*95-12\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)+10*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)- 80*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)-3.5\left(\frac{(1+0.02)^{10+1}-1}{0.02}\right)+7\left(\frac{(1+0.25)^{10+1}-1}{0.25}\right)-300+50$$

$$\boldsymbol{MPF} =_{12}\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)-10*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)-7\left(\frac{(1+0.25)^{10+1}-1}{0.25}\right) +\max\left\{80*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right),700*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)\right\}-\max(95*10,100*10)$$

$$\boldsymbol{MPF} = 50-700+\max\left[3.5\left(\frac{(1+0.02)^{10+1}-1}{0.02}\right)-1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right),7\left(\frac{(1+0.25)^{10+1}-1}{0.25}\right)-1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right)\right] +\max\left(100*10-95*20,100*20-12\left(\frac{(1+0.05)^{10+1}-1}{0.05}\right)\right)+0.20*80\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)-0.20*700\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)$$

Results

Retrofitting Profit Function (RPF)=731.148 Lacs

Maintenance Profit Function (MPF)=- 63.400 Lacs

New Machine Profit Function (NMPF)=396.538 Lacs

Case study: 2

1. Present asset value of the machine under study (in lacs): 10
2. Cost of the new machine (in lacs): 700
3. Maintenance cost of machine under study (in lacs): 7
4. Cost of Retrofitting/Reconditioning/Upgradation of the machine under study (in lacs): 800
5. Effect of technology on the capacity of new machine.
6. Rate of production decay of the machine under study (in %/100): 0.05
7. Capacity of New Machine (in lacs): 100
8. Capacity of machine after Retrofitting/Reconditioning/ Upgradation (in lacs): 95
9. Life of machine after Retrofitting/Reconditioning/Upgradation (in yrs) (in years): 10
10. Life of a new Machine (in yrs) (in years): 20
11. Rate of increase of Maintenance cost of machine under study (in %/100): 0.25
12. Maintenance cost after Retrofitting/Reconditioning/ Upgradation (in lacs)): 3.5
13. Rate of increase of Maintenance cost of machine after Retrofitting/ Reconditioning/Upgradation (in %/100): 0.02
14. Capacity of machine under study (in lacs): 12
15. Salvage value of the machine under study (in lacs): 50
16. Maintenance cost of new machine (in lacs): 1
17. Rate of increase of Maintenance cost of new (in %/100): 0.01
18. Rate of Depreciation of Assets (in %/100): 0.05
19. Rate of taxation (in %/100): 0.20
20. Asset Value of Retrofitted Machine (in lacs): 80

$$RPF = 10*95-12((1-(1-0.05)^{(10+1)})/0.05)+10*0.20((1-(1-0.05)^{(10+1)})/0.05)-80*0.20((1-(1-0.05)^{(10+1)})/0.05)- 3.5(((1+0.02)^{(10+1)}-1)/0.02)+7(((1+0.25)^{(10+1)}-1)/0.25)-800+50$$

$$MPF = 12((1-(1-0.05)^{(10+1)})/0.05)-10*0.20((1-(1-0.05)^{(10+1)})/0.05)-7(((1+0.25)^{(10+1)}-1)/0.25) +max80*0.20((1-(1-0.05)^{(10+1)})/0.05),700 *0.20((1-(1-0.05)^{(10+1)})/0.05)-max(95*10,100*10)$$

$$\boldsymbol{NMPF} = 50-700+\max\left[3.5\left(\frac{(1+0.02)^{10+1}-1}{0.02}\right)-1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right),7\left(\frac{(1+0.25)^{10+1}-1}{0.25}\right)-1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right)\right] +\max\left(100*10-95*20,100*20-12\left(\frac{(1+0.05)^{10+1}-1}{0.05}\right)\right)+0.20*80\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)-0.20*700\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)$$

Results

Maintenance Profit Function (MPF): - 63.400 Lacs

Retrofitting Profit Function (RPF): 231.148 Lacs

New Machine Profit Function (NMPF): 396.538 Lacs

Case study: 3

1. Present asset value of the machine under study (in lacs): 10
2. Cost of the new machine (in lacs): 700
3. Maintenance cost of machine under study (in lacs): 1

4. Cost of Retrofitting/Reconditioning/Upgradation of the machine under study (in lacs): 800.
5. Effect of technology on the capacity of new machine.
6. Rate of production decay of the machine under study (in %/100): 0.01
7. Capacity of New Machine (in lacs): 100
8. Capacity of machine after Retrofitting/Reconditioning/ Upgradation (in lacs): 100
9. Life of machine after Retrofitting/Reconditioning/Upgradation (in yrs) (in years): 10
10. Life of a new Machine (in yrs) (in years): 20
11. Rate of increase of Maintenance cost of machine under study (in %/100): 0.01
12. Maintenance cost after Retrofitting/Reconditioning/ Upgradation (in lacs)): 3.5
13. Rate of increase of Maintenance cost of machine after Retrofitting/ Reconditioning/ Upgradation (in %/100): 0.02
14. Capacity of machine under study (in lacs): 100
15. Salvage value of the machine under study (in lacs): 100
16. Maintenance cost of new machine (in lacs): 1
17. Rate of increase of Maintenance cost of new (in %/100): 0.01
18. Rate of Depreciation of Assets (in %/100): 0.05
19. Rate of taxation (in %/100): 0.20
20. Asset Value of Retrofitted Machine (in lacs): 80

$$\boldsymbol{RPF} = 10*100 - 100\left(\frac{1-(1-0.01)^{10+1}}{0.01}\right) + 10*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right) - 80*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right) - 3.5\left(\frac{(1+0.02)^{10+1}-1}{0.02}\right) + 1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right) - 800 + 100$$

$$\boldsymbol{MPF} = 100\left(\frac{1-(1-0.01)^{10+1}}{0.01}\right) - 10*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right) - 1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right) + \max\left\{80*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right), 700*0.20\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)\right\} - \max(100*10, 100*10)$$

$$\boldsymbol{NMPF} = 100 - 700 + \max\left[3.5\left(\frac{(1+0.02)^{10+1}-1}{0.02}\right) - 1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right), 1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right) - 1\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right)\right] + \max\left(100*10 - 100*20, 100*20 - 100\left(\frac{(1+0.01)^{10+1}-1}{0.01}\right)\right) + 0.20*80\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right) - 0.20*700\left(\frac{1-(1-0.05)^{10+1}}{0.05}\right)$$

Results

Maintenance Profit Function (MPF): 225.729 Lacs

Retrofitting Profit Function (RPF): - 898.377 Lacs

New Machine Profit Function (NMPF): - 638.352 Lacs

The comparison of case studies and the results of all case studies could be viewed in the following Figure 1 and Table 1.

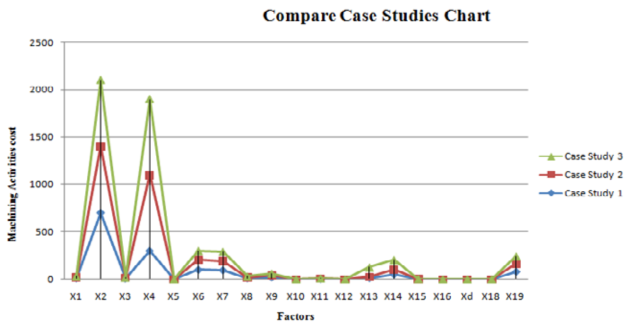

Figure 1: Compare case studies chart.

Factors	Case Study 1	Case Study 2	Case Study 3
X1	10 lacs	10 lacs	10 lacs
X2	700 lacs	700 lacs	700 lacs
X3	7 lacs/yr	7 lacs	1 lacs
X4	300 lacs	800 lacs	800 lacs
X5	……	……	……
X6	5%	5%	1%
X7	100 lacs/yr	100 lacs	100 lacs
X8	95 lacs/yr	95 lacs/yr	100 lacs
X9	10 years	10 years	10 years
X10	20 years	20 years	20 years
X11	25%	25%	1%
X12	3.5 lacs/yr	3.5 lacs/yr	3.5 lacs
X13	2%	2%	2%
X14	12 lacs/yr	12 lacs	100 lacs
X15	50 lacs	50 lacs	100 lacs
X16	1 lac/yr	1 lacs	1 lacs
X17	1%	1%	1%
Xd	5%	5%	5%
X18	20%	20%	20%
X19	80 lacs	80 lacs	80 lac
RPF	**731.148Lacs**	**231.148 Lacs**	**- 898.377 Lacs**
MPF	**- 63.400 Lacs**	**-63.400 Lacs**	**225.729 Lacs**
NMPF	**396.538 Lacs**	**396.538 Lacs**	**- 638.352 Lacs**

Table 1: Result of all the case studies with input parameters.

Conclusion

This work is based on taking decision regarding Retrofitting, New Machines and Maintenance of the present Machine available. In this I have identified some factors from journals, research papers and from industrial surveys on the basis of that I have generate formulas to calculate three kind of conditions of profit functions and cost of the machine which are:

1. **RPF**: Retrofitting Profit Function
2. **NMPF**: New Machine Profit Function
3. **MPF**: Maintenance Profit Function

These conditions play very important role during taking decision and also will create a big effect in production.

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