# Implementation of Analytical Hierarchy Process in Two Wheeler Maintenance

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***Abstract*- The main purpose of introducing Analytical Hierarchy Process in Automobile maintenance is to reduce the Time and cost of maintenance of a automobile in an automotive service station and also to give necessary information about the maintenance done in an vehicle to the customer and also to the service engineer.**

**The Model was developed using Cost and Time analysis of several maintenance of automobile components and parts. Then different failure modes and analyzed values of maintenance is then feed to AHP to get sequential ranking of the failures.**

***Index Terms*- Analytical Hierarchy Process(AHP), Scales, Ratio.**

## 1. INTRODUCTION

In today's competitive world paying attention to servicing (maintenance) of customer owned vehicle according to required time, cost and achievable quality to the customer after marketing is also more important to develop the reputation of the Automotive maintenance organization.

Selecting a wrong strategy in the maintenance can cause a disaster in increasing costs and wasting time. Therefore, this process would show a method in order to choose the best maintenance strategy in a safe climate.

In Complex situation of Maintenance a consultant to find the best maintenance strategies for different parts of the Automotive components in motorcycle(2-wheelers) in order to meet the goal of the aftermarket service that is to give the best service to the customer.

## 2. FAILURE MODES

The failure mode of two-wheeler maintenance is classified according to major components to be maintained periodical and also based on the common failure that occur During the operation of the 2-wheeler.

1. Starting failure
2. Transmission failure
3. Throattling and Carburator failure
4. Brakes and Suspension failure
5. Other failures (Indicators, display units and Wiring arrangement etc)

## 3. COST AND TIME ANALYSIS FOR MAINTENANCE

Cost and time of maintenance of the two wheeler is analysed based on analysis of major complaints of customers and also the common failure that have been occurred in 2-wheelers for the past years in several automotive maintenance shops by which it is tabulated, the values are given according to the major maintenance of the 2-wheeler. It is not applicable to vehicles that have been operated more than 1,00,000kilometres and above.

### 3.1 COST ESTIMATION FOR MAINTENANCE

The maximum cost estimated for a general maintenance of a two wheeler is between1000 to 2500 (Varies according to vehicle design and performance), this cost analysed to current value of the components it may vary according to the value of money.

Table 1 Cost estimation for maintenance of 2-wheeler

| General Failure Modes | COST OF MAINTENANCE | |
|---|---|---|
| | Minimum Cost (Rs.) | Maximum Cost(Rs.) |
| Starting failure | 100 | 200 |
| Transmission failure | 600 | 800 |
| Throattling system | 75 | 200 |
| Brakes & Suspension | 50 | 200 |
| Other Components | 300 | 600 |
| Total Cost | 1125 | 2000 |

3.2 TIME ESTIMATED FOR MAINTENANCE

| Table 4 Normalized Matrixes | | |
|---|---|---|
| Factors | Cost | Time |
| Cost | 0.67 | 0.67 |
| Time | 0.33 | 0.33 |
| Colum Sum | 1 | 1 |

The maximum Time estimated for a general maintenance of two-wheeler is between 1hr 40 min but we can reduce it between 20 to 30 min by introducing the AHP concept in maintenance by several analytical Calculation the following are the data that are analysed from several two-wheeler automotive service station and the average value is tabulated

Table 2 Time required for maintenance of 2-wheeler

| General Failure Modes | TIME TAKEN FOR MAINTENANCE | |
|---|---|---|
| | Minimum time taken (min) | Maximum time taken(min) |
| Starting failure | 10 | 20 |
| Transmission failure | 20 | 25 |
| Throattling system | 10 | 20 |
| Brakes & Suspension | 10 | 15 |
| Other Components | 20 | 20 |
| Total Time Taken | 70 | 100 |

4. ANALYTICAL HIERARCHY PROCESS (AHP)

AHP deals with complex, unstructured and multi-attribute decision problems. The application of AHP is widely accepted in various areas such as operation management, manufacturing, economics, business, and information technology. With its ability to human opinions in structuring a complex and multi-attribute problem, AHP has significantly improved the performance of the decision-making process in organizations. Here the AHP is used to give mathematical relation in selection of failure process in maintenance of 2-wheeler according to the customer and service men. The below AHP has been formulated according to the customer requirement on cost and time

4.1. AHP on Time and Cost of Maintenance

Table 3 Reciprocal Matrix & Comparison Matrix

| Factors | COST | TIME |
|---|---|---|
| COST | 1 | 2 |
| TIME | 0.5 | 1 |
| COLUM SUM | 1.5 | 3 |

Normalized Principal Eigen Vector Matrix

| | | | |
|---|---|---|---|
| W=1/2 | 1.34 | = | 0.67 |
| | 0.66 | | 0.33 |

$\lambda max = 2$

$CI = \lambda_{max} - n / (n-1) = 0$

$CR = CI / RI = 0 < 10\%$ (Since, RI = 0 for N=2)

4.2. AHP ON COST OF MAINTENANCE

Table 5 Reciprocal Matrix & Comparison Matrix

| Factors | Starting failure | Transmission failure | Throattling system | Brakes & Suspension | Other Components |
|---|---|---|---|---|---|
| Starting failure | 1 | 1 | 3 | 5 | 7 |
| Transmission failure | 1 | 1 | 2 | 3 | 5 |
| Throattling system | 0.333 | 0.5 | 1 | 2 | 4 |
| Brakes & Suspension | 0.2 | 0.333 | 0.5 | 1 | 2 |
| Other Components | 0.1429 | 0.2 | 0.25 | 0.5 | 1 |
| COLUM SUM | 2.6759 | 3.033 | 6.75 | 11.5 | 19 |

Table 6 Normalized Matrixes

| Factors | Starting failure | Transmission failure | Throattling system | Brakes & Suspension | Other Components |
|---|---|---|---|---|---|
| Starting failure | 0.3741 | 0.33 | 0.444 | 0.4347 | 0.37 |
| Transmission failure | 0.3741 | 0.33 | 0.2962 | 0.261 | 0.2631 |
| Throattling system | 0.12346 | 0.165 | 0.14814 | 0.174 | 0.211 |
| Brakes & Suspension | 0.0748 | 0.1089 | 0.074 | 0.087 | 0.105 |
| Other Components | 0.05374 | 0.066 | 0.037 | 0.0435 | 0.0526 |
| COLUM SUM | 1 | 1 | 1 | 1 | 1 |

Normalized Principal Eigen Vector Matrix

| | | | |
|---|---|---|---|
| | 1.95 | | 0.39 |
| | 1.52 | | 0.31 |
| W = 1/5 | 0.82 | = | 0.16 |
| | 0.45 | | 0.089 |
| | 0.253 | | 0.051 |

$\lambda max = 5.074$

$CI = \lambda_{max} - n / (n-1) = 0.0185$

$CR = CI / RI = 0.02 < 10\%$ (Since, RI = 1.12 for N=5)

4.3. AHP ON TIME OF MAINTENANCE

Table 7 Reciprocal Matrix & Comparison Matrix

| Factors | Starting failure | Transmission failure | Throattling system | Brakes & Suspension | Other Components |
|---|---|---|---|---|---|
| Starting failure | 1 | 2 | 5 | 4 | 3 |
| Transmission failure | 0.5 | 1 | 5 | 3 | 6 |
| Throattling system | 0.2 | 0.2 | 1 | 0.1429 | 0.25 |
| Brakes & Suspension | 0.25 | 0.333 | 7 | 1 | 2 |
| Other Components | 0.333 | 0.1667 | 4 | 0.5 | 1 |
| COLUM SUM | 2.283 | 3.6997 | 22 | 8.6429 | 12.25 |

Table 8 Normalized Matrixes

| Factors | Starting failure | Transmission failure | Throattling system | Brakes & Suspension | Other Components |
|---|---|---|---|---|---|
| Starting failure | 0.43 | 0.54 | 0.22 | 0.46 | 0.24 |
| Transmission failure | 0.22 | 0.27 | 0.22 | 0.34 | 0.48 |
| Throattling system | 0.08 | 0.05 | 0.05 | 0.016 | 0.02 |
| Brakes & Suspension | 0.11 | 0.08 | 0.31 | 0.11 | 0.16 |
| Other Components | 0.14 | 0.04 | 0.18 | 0.05 | 0.08 |
| COLUM SUM | 1 | 1 | 1 | 1 | 1 |

Normalized Principal Eigen Vector Matrix

| | | | |
|---|---|---|---|
| | 1.89 | | 0.38 |
| | 1.53 | | 0.31 |
| W = 1/5 | 0.22 | = | 0.04 |
| | 0.77 | | 0.15 |
| | 0.49 | | 0.098 |

$\lambda max = 5.39$

$CI = \lambda_{max} - n / (n-1) = 0.0978$

$CR = CI / RI = 0.087 < 10\%$

| N | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| RI | 0 | 0 | 0.58 | 0.9 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.49 |

## 5. CONCLUSION

In this paper the current maintenance cost and time of a Two-wheeler has been analysed and calculated in order to establish the complete information of the time and cost required for the maintenance of a Two-wheeler to the customer and also to reduce the time of maintenance by following necessary sequence as per the calculation by the service men (fresher) in the maintenance shop. Then AHP have been applied to find what are the failure modes that take more time and cost during maintenance and in the result Transmission failure is found to be the major contributing factor and the time taken for that failure can be reduced by increasing man power or adopting separate timing for such vehicles having common failure.

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