A REPORT TO THE MANAGEMENT TEAM OF TORRE CARS

1. **Executive Summary:**

The aim of this report is to analyse the present situation at Torre cars related to the quality score of production and the level of complaints corresponding to them. This report deals with the production line between 2015-16 with 853 final products. There are few concerns raised by the management regarding the quality of the production. These are analysed with various factors, statistical tests are performed to find insights (association and correlation) evidences to recommend the management team of the company.

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**2.Introduction**

In this Report we analyse the production of Torre cars for the financial year 2015-16. This deals with initial analysis on the current situation of the company, then it analyses the factors affecting the quality score of the cars and the customer complaints.

This report establishes notable insights on the relationship between each factor that influences the quality score of the production.

The management of the company has raised few concerns on the production time, sales, and procurement of components from other suppliers.

**To be precise:**

* Relating Production in numbers to the corresponding number of complaints
* Basic Conventional models seem to have more issue.
* Production time reduction and Staffs turnover.

These problems are analysed with the following Hypothesis considered :

1. To analyse if there is a Relationship between the Models and Complaints.
2. To analyse if there is a Relationship between Quality Scores and the Complaints.
3. To analyse if there is a Relationship between Production time and Quality.
4. To analyse if there is a Relationship between basic and advanced mechanical components.

**3. Analysis**

**3.1. Current situation at Torre**

**3.1.1. Introduction:**

Torre Cars is a small specialised manufacturer producing “technologically advanced cars with character”. The current Annual production capacity is about 450 cars despite the relatively high cost. During the financial year 2015-16, Torre cars managed to sell 853 cars.

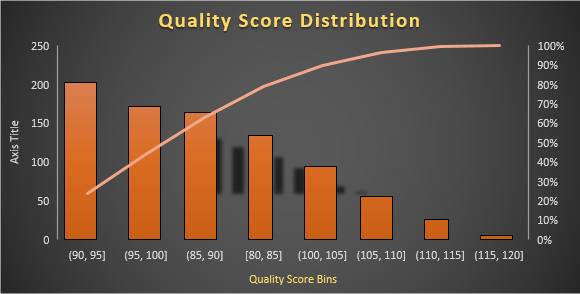
As per figure 1.0, The bestselling model is 2 with 50% of the overall production and model 4 marks the least sold . (Refer Appendix C – table2.0)

***Figure -1.0 Car Sales –(2015-16)/Numerical data is in Appendix - C***

**3.1.2. Quality Score**

Quality score for individual models is analysed in this section. From figure 2.0 we could infer that the average quality score of model 4 is high and model 1 being the least. We can also notice that the average quality score of Basic models is less compared to the other two models. (Appendix C – table 3.0).

***Figure 2.0 – Average Quality Score on models***



***Figure 3.0 – Quality Score Distribution***

From the figure – 3.0 we can infer that the Quality scores of 237 cars is between [90 , 95] and around 180 cars have quality scores >100,Out of which more than 70% is model 2 cars.

**3.1.3. Complaints**

The present Complaints situation of the company is analysed in this section, we could see that there are four levels of complaints:

• level 0: no complaints;

• level 1: minor complaints but no action required;

• level 2: significant complaints;

• level 3: serious complaints;

From figure 4.0 we could see that there is only 19.7 % of complaints fall under minor, significant and serious category, around 80% of the overall production is successful with no complaints. (Refer Table 4.0 – Appendix C)

***Figure 4.0 – Individual Percentage of Level of Complaints***

Complaint levels of each model is analysed and the percentage of each model corresponding to the complaint levels are found. From the figure 5.0 we could infer that more than 50% of the model 2 is with no complaints,50% of the model 1 has the serious complaints and Model 4 has no serious complaints. (Refer Table 4.0 Appendix –C)

***Figure 5.0 – Models vs Level of Complaints***

From the above figure it is very clear that the models with basic components has the higher percentage of serious complaints.

**3.2. Analysis of Complaints/Quality score: (Hypothesis)**

After all the initial analysis, we need to consider the Various hypothesis to find if there is any association amongst quality score, complaints, production time, models and analyse in detail.

1. It is intriguing on **Hypothesis 1** is concerned to draw insights from the data and analyse the association between the complaints and models. Chi square test has been performed and it can have identified that there is difference between observed and expected values.

**Hypothesis:**

H0  :There is no association between Models and Complaints

H1 : There is an association between Models and Complaints

Significance level ** = 5%**

X2 (Calculated) = 30.70

Degrees of Freedom = 9

Critical value of chi square (5%) = 16.92

**X2 > 16.92**

**(Performed Chi square test detailed explanation in Appendix -A)**

1. According to **Hypothesis 2** is concerned, we intend to analyse the relation between Quality score and Complaints. Complaints are grouped as :

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Actions \Level of Complaints** | **Minor** | **Major** | **Significant** | **Serious** |
| **Action required** | **No** | **No** | **yes** | **yes** |
| **Action not required** | **Yes** | **Yes** | **No** | **No** |

Two independent sample t test has been performed to find if there is any association between Quality score and the complaints.

**Hypothesis:**

H0 : There is no association between Quality Score and Complaints

H1 : There is an association between Quality Score and Complaints

Significance level  = 5 %

For

t = 9.63

Df = 76 (n1+n2 -2)

Critical value (76,0.05) = **1.66**

**( Performed Two independent sample t test detailed explanation in Appendix -B)**

1. **Hypothesis 3** analyses the correlation between the production time and the quality score, a linear regression is performed to find the strength of the association between the two with the Correlation coefficient determination value R^2. **(Complete analysis is done in 3.3 Production time section below and for Correlation coefficient data details refer Appendix – C table 5.0)**
2. **Hypothesis 4** analyses the association between the basic and advanced mechanical components over the complaints using a chi square test again.

Chi Square Test has been performed to find if there is any association between the Basic components and the complaints.

**Hypothesis:**

H0  :There is no association between Basic Model (With basic components) and Complaints

H1 :There is an association between Basic Model (With basic components)and Complaints

Significance level ** = 5%**

X2  = 12.06

Degrees of Freedom =3

Critical value of chi square (5%) = 7.08 => **X2 > 7.08**

**( Performed Chi square test detailed explanation in Appendix –D)**

**3.3. Production time**

According to the initial hypothesis is considered, we need to analyse the take on Production Time over the Quality score. After analysing from the given data we could see that

***Figure 6.0 – Linear Regression (Mechanical Time vs Quality Score)***

From the above figure 6.0 we can see that there is a reasonably good positive correlation between the Mechanical time and the Quality of the car.

***Figure 7.0,8.0 Electric time vs Quality Score for Both Conventional and Hybrid Models***

From the above figures 7.0,8.0 we could see that electric time has weak positive correlation for hybrid models and for conventional model electric time is zero.

***Figure 9.0 – Linear Regression (Total Production time vs Quality Score)***

From the above figure it is clear that there is a positive correlation between the total production time and the quality.

***Figure 10.0 – Linear Regression (Paint Time vs Quality Score)***

From the above regression graph and R^2 value we can confirm that there is no correlation between the Painting time and the Quality of the cars .

From all the above analysis of production time , we could infer that production time has positive correlation with the Quality Score.

**Inference:** Changes in production time impacts the Quality score due to the positive correlation between them .

**5.Recommendations:**

* From the above analysis it is evident that the models with basic components tend to have more complaints, so it is recommended to change supplier for these components.
* We found there is a positive correlation between the production time and the quality, so reducing the production time is not advisable.
* To consider decreasing the levels of high staff turnover as it is directly affecting the quality of the product.
* Since we are analysing only the 2015-16 data, we need further information gathered on various other factors (eg: cost, procurement etc) that influences the quality of the models.

**6.Conclusion:**

* After analysing all the factors, we can conclude that the models with basic components have more number of serious complaints.
* Model 2 is the best sold model for the financial year 2015-16 which accounts to 50%of the overall production with maximum no complaints. Model 2 is a successful model for this year 2015-16.
* Each phase of production requires more attention since it has notable impact on the quality and delivery. Since this factor remains the base for the upcoming years production.

**Appendix – A**

Chi Square Test has been performed to find if there is any association between the level of complaints and the models of the car.

**Hypothesis:**

H0  :There is no association between Models and Complaints

H1 : There is an association between Models and Complaints

Significance level ** = 5%**

X2 (Calc) = 30.70

Degrees of Freedom = 9

Critical value of chi square (5%) = 16.92

From the above analysis it is clear that X2 is greater that the Critical value of chi square.

**X2(calc) > 16.92**

Hence, H0 doesn’t hold and it can be rejected in favour of H1 at 5% Significance levelyb .

**From the above statistical analysis using Chi square test we could see that there is an association between the Models and the level of complaints.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Observed** |  |  |  |  |  |  |
|  | Complaints | 0 | 1 | 2 | 3 | Total |
|  | Model 1 | 126 | 22 | 17 | 7 | 172 |
|  | Model 2 | 368 | 34 | 29 | 3 | 434 |
|  | Model 3 | 110 | 13 | 6 | 4 | 133 |
|  | Model 4 | 81 | 21 | 12 | 0 | 114 |
|  | Grand Total | 685 | 90 | 64 | 14 | 853 |
|  |  |  |  |  |  |  |
| **Expected** |  |  |  |  |  |  |
|  | Complaint | 0 | 1 | 2 | 3 |  |
|  | Model 1 | 138.12 | 18.15 | 12.91 | 2.82 | 172.00 |
|  | Model 2 | 348.52 | 45.79 | 32.56 | 7.12 | 434.00 |
|  | Model 3 | 106.81 | 14.03 | 9.98 | 2.18 | 133.00 |
|  | Model 4 | 91.55 | 12.03 | 8.55 | 1.87 | 114.00 |
|  |  |  |  |  |  |  |
| **Chi Square** |  |  |  |  |  |  |
|  | Complaint | 0 | 1 | 2 | 3 |  |
|  | Model 1 | 1.06 | 0.82 | 1.30 | 6.18 |  |
|  | Model 2 | 1.09 | 3.04 | 0.39 | 2.39 |  |
|  | Model 3 | 0.10 | 0.08 | 1.59 | 1.51 |  |
|  | Model 4 | 1.22 | 6.69 | 1.39 | 1.87 |  |
|  |  |  |  |  |  |  |
|  | **X^2 (Calc) =** | 30.70 |  |  |  |  |
|  | **Degrees of Freedom =** | 9 |  |  |  |  |
|  | **Critical Chi Square =** | 16.92 |  |  |  |  |

**Appendix- B**

independent sample t test has been performed to find if there is any association between Quality score and the complaints.

**Hypothesis:**

H0  :There is no association between Quality Score and Complaints

H1 : There is an association between Quality Score and Complaints

Significance level ** = 5 %**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Row Labels** | **Sum of quality score** | **Count of quality score** | **Mean of quality score** | **Std.Dev of quality score** |
| Major | 8481 | 90 | 94.23333333 | 7.257773825 |
| Minor | 64898 | 685 | 94.74160584 | 8.19224996 |
| Serious | 1180 | 14 | 84.28571429 | 2.301456777 |
| Significant | 5792 | 64 | 90.5 | 5.371884479 |
| **Grand Total** | **80351** | **853** | **94.19812427** | **8.02969233** |

***Table – 1.0***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Complaints** | **Sum** | **Observations** | **Mean** | **Std.Deviation** |
| **Serious** | 1180 | 14 | 84.29 | 2.30 |
| **Significant** | 5792 | 64 | 90.50 | 5.37 |

**t = 9.63**

t is +ve so we perform a right tailed test now,

Df = (n1+n2-2) => 64+14 -2 =76

Critical value (76,0.05) = **1.66**

**t > (critical value)** t is greater than the critical value

From the above analysis it is clear that, Critical value is less than the t value of the test.

Hence, H0 doesn’t hold and it can be rejected in favour of H1 .

**From the above statistical analysis using t test we could see that there is an association between the Quality Score and complaints with significant difference in their mean.**

**Appendix –C**

|  |  |  |
| --- | --- | --- |
| **Row Labels** | **Count of model** | **Sum of model** |
| 1 | 172 | 172 |
| 2 | 434 | 868 |
| 3 | 133 | 399 |
| 4 | 114 | 456 |
| **Grand Total** | **853** | **1895** |

***Table – 2.0***

|  |  |
| --- | --- |
| **Row Labels** | **Average of quality score** |
| 1 | 89.97093023 |
| 2 | 95.89400922 |
| 3 | 91.52631579 |
| 4 | 97.23684211 |
| **Grand Total** | **94.19812427** |

***Table- 3.0***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Count of complaint** |  |  |  |  |  |
| **Complaints\Models** | **1** | **2** | **3** | **4** | **Grand Total** |
| 0 | 126 | 368 | 110 | 81 | 685 |
| 1 | 22 | 34 | 13 | 21 | 90 |
| 2 | 17 | 29 | 6 | 12 | 64 |
| 3 | 7 | 3 | 4 |  | 14 |
| **Grand Total** | **172** | **434** | **133** | **114** | **853** |

***Table – 4.0***

|  |  |  |
| --- | --- | --- |
| **Time Spent on** | **R^2** | **R** |
| Mechanical Time | 0.5294 | 0.727599 |
| Electric time(Hybrid) | 0.3148 | 0.56107 |
| Paint time | 0.0023 | 0.047958 |
| Total Time | 0.2733 | 0.522781 |

***Table -5.0***

**Appendix – D**

Chi Square Test has been performed to find if there is any association between the Basic components and the complaints.

**Hypothesis:**

H0  :There is no association between Basic Model (With basic components) and Complaints

H1 : There is an association between Basic Models (With basic components)and Complaints

Significance level ** = 5%**

X2  = 12.06

Degrees of Freedom =3

Critical value of chi square (5%) = 7.08

From the above analysis it is clear that X2 is greater that the Critical value of chi square.

**X2 > 7.08**

Hence, H0 doesn’t hold and it can be rejected in favour of H1 .

**From the above statistical analysis using Chi square test we could see that there is an association between the Basic Models (with basic components )and the complaints.**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| **Observed** |  |  |  |  |  |  |
|  | **Count of complaint** | **Column Labels** | |  |  |  |
|  | **Row Labels** | **0** | **1** | **2** | **3** | **Grand Total** |
|  | Advanced | 449 | 55 | 41 | 3 | 548 |
|  | Basic | 236 | 35 | 23 | 11 | 305 |
|  | **Grand Total** | **685** | **90** | **64** | **14** | **853** |
|  |  |  |  |  |  |  |
| **Expected** |  |  |  |  |  |  |
|  | **Components\Complaints** | **0** | **1** | **2** | **3** | **Total** |
|  | **Advanced** | 440.07034 | 57.819 | 41.1161 | 8.99414 | 548 |
|  | **Basic** | 244.92966 | 32.181 | 22.8839 | 5.00586 | 305 |
|  |  |  |  |  |  |  |
| **Chi Square** |  |  |  |  |  |  |
|  | **Components\Complaints** | 0 | 1 | 2 | 3 |  |
|  | **Advanced** | 0.1811956 | 0.1375 | 0.00033 | 3.99479 |  |
|  | **Basic** | 0.3255581 | 0.247 | 0.00059 | 7.17752 |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  | **X^2 =** | 12.064494 |  |  |  |  |
|  | **Degrees of Freedom =** | 3 |  |  |  |  |
|  | **Critical Chi square =** | 7.81 |  |  |  |  |