

**Assessment 2: Case study analysis**

**Action Plan**

Author: Bertocco Thomas-Killian - #13758322

Lecturer: Eddie Chng

CO5124 Data Analysis and Decision Modelling | SP52 | 2019

5 September 2019

Table of Contents

[Issue 1: Determine current average pricing of the accommodation by brands, states, and locations. 3](#_Toc18507911)

[Action plan 3](#_Toc18507912)

[Issue 2: Determine whether price differentiation exists among the accommodation brands. 4](#_Toc18507913)

[My hypothesis 4](#_Toc18507914)

[Action Plan 4](#_Toc18507915)

[Results 6](#_Toc18507916)

[Issue 3: Determine whether price differentiation exists between states among the accommodation brands. 8](#_Toc18507917)

[My hypothesis 8](#_Toc18507918)

[Action Plan 8](#_Toc18507919)

[Results 11](#_Toc18507920)

[Issue 4: Determine whether price differentiation exists between locations among the accommodation brands. 12](#_Toc18507921)

[My hypothesis 12](#_Toc18507922)

[Action Plan 12](#_Toc18507923)

[Results 15](#_Toc18507924)

[Issue 5: Determine if the introduction of the Comfort brand has increased internal competition among the other accommodation brands. 15](#_Toc18507925)

[My hypothesis 15](#_Toc18507926)

[Action Plan 15](#_Toc18507927)

[Resort results 18](#_Toc18507928)

[Cottage results 20](#_Toc18507929)

[Classic results 23](#_Toc18507930)

[Global results 23](#_Toc18507931)

## Issue 1: Determine current average pricing of the accommodation by brands, states, and locations.

### Action plan

1. **Construct a Pivot Table from the data give.**
2. **Rearrange the Pivot Table fields to present the required information.**

Average pricing of accommodation by brands:

|  |  |  |
| --- | --- | --- |
| **Brand** | **Nbr of Hotel** | **Average Price** |
| Resort | 48 | 200.2704167 |
| Cottage | 48 | 202.65625 |
| Classic | 48 | 201.4627083 |
| **Grand Total** | **144** | **201.463125** |

Average pricing of accommodation by states:

|  |  |  |
| --- | --- | --- |
| **State** | **Nbr of Hotel** | **Average Price** |
| NSW | 48 | 201.02375 |
| QLD | 48 | 202.196875 |
| VIC | 48 | 201.16875 |
| **Grand Total** | **144** | **201.463125** |

Average pricing of the accommodation by locations:

|  |  |  |
| --- | --- | --- |
| **Location** | **Nbr of Hotel** | **Average Price** |
| Metropolitan Cities | 72 | 201.5591667 |
| Regional Cities | 72 | 201.3670833 |
| **Grand Total** | **144** | **201.463125** |

## Issue 2: Determine whether price differentiation exists among the accommodation brands.

### My hypothesis

From the data previously collected, I can observe that the difference between the average prices of hotels of different brands is negligible. Therefore, I assume that there are no price differences between brands.

We will verify this hypothesis through statistical tests.

### Action Plan

1. **Sort the data by brand, copy, and restructure the data into three columns by brand name.**

Pricing of the accommodation by brands:

|  |  |  |
| --- | --- | --- |
| Resort | Cottage | Classic |
| 195.00 | 197.63 | 196.11 |
| 195.66 | 198.14 | 196.22 |
| 195.71 | 198.43 | 196.84 |
| 195.77 | 198.43 | 196.86 |
| 197.84 | 198.58 | 197.16 |
| 198.21 | 198.60 | 197.78 |
| 198.29 | 198.62 | 198.20 |
| 198.36 | 198.67 | 198.28 |
| 198.58 | 199.18 | 198.49 |
| 198.88 | 200.71 | 198.58 |
| 198.98 | 200.91 | 198.66 |
| 199.05 | 200.93 | 198.85 |
| 199.13 | 201.08 | 198.90 |
| 199.16 | 201.17 | 198.92 |
| 199.18 | 201.27 | 199.18 |
| 199.18 | 201.47 | 199.31 |
| 199.20 | 201.75 | 199.45 |
| 199.21 | 201.77 | 200.11 |
| 199.25 | 201.83 | 200.63 |
| 199.38 | 202.22 | 200.67 |
| 199.43 | 202.31 | 200.72 |
| 199.45 | 202.53 | 200.86 |
| 199.49 | 202.55 | 200.90 |
| 199.55 | 202.65 | 200.97 |
| 199.55 | 202.74 | 201.02 |
| 199.61 | 202.76 | 201.37 |
| 199.71 | 202.82 | 201.39 |
| 199.87 | 202.83 | 201.46 |
| 199.92 | 202.88 | 201.83 |
| 199.99 | 202.94 | 201.86 |
| 200.20 | 203.03 | 201.89 |
| 200.26 | 203.17 | 201.96 |
| 200.58 | 203.19 | 202.02 |
| 200.64 | 203.31 | 202.17 |
| 200.65 | 203.48 | 202.32 |
| 200.84 | 203.69 | 202.73 |
| 201.66 | 203.79 | 203.25 |
| 202.07 | 203.93 | 203.56 |
| 202.49 | 204.05 | 204.69 |
| 202.50 | 204.10 | 205.52 |
| 202.58 | 204.49 | 205.62 |
| 203.02 | 204.51 | 205.93 |
| 204.08 | 207.20 | 206.15 |
| 204.69 | 208.79 | 207.01 |
| 205.99 | 208.79 | 207.45 |
| 206.12 | 209.06 | 208.30 |
| 207.01 | 209.95 | 208.41 |
| 207.01 | 210.57 | 209.65 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for Resort brand

µ2 = average price for Cottage brand

µ3 = average price for Classic brand

h0: µ1 = µ2 = µ3

**Alternate hypothesis**

h1: at least one accommodation brand average price (µ) is different

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

Reject h0 if p-value < α.

1. **Use the One-Way ANOVA with the Tukey-Kramer procedure**

The One-Way ANOVA is used because we want to test the equality between three means based on one factor: The brand.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Anova: Single Factor** | |  |  |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY | |  |  |  |  |  |
| *Groups* | *Count* | *Sum* | *Average* | *Variance* |  |  |
| Resort | 48 | 9612.98 | 200.2704 | 7.43396578 |  |  |
| Cottage | 48 | 9727.5 | 202.6563 | 9.547049468 |  |  |
| Classic | 48 | 9670.21 | 201.4627 | 11.51820315 |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Between Groups | 136.6128 | 2 | 68.30641 | 7.190346097 | 0.001063 | 3.060292 |
| Within Groups | 1339.463 | 141 | 9.499739 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 1476.076 | 143 |  |  |  |  |

**Tukey-Kramer procedure**

Number of groups k = 3

Degrees of freedom df = 143

Q Statistic = 3.31

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Comparison** | Absolute Difference | Std. Error of Difference | Critical Range | **Results** |
| **Group 1 to Group 2** | 2.385833 | 0.44487216 | 1.473 | **Means are different** |
| **Group 1 to Group 3** | 1.192292 | 0.44487216 | 1.473 | **Means are not different** |
| **Group 2 to Group 3** | 1.193542 | 0.44487216 | 1.473 | **Means are not different** |

### Results

Anova single factor:

* p-value (0.001063) < α (0.05). h0 is rejected.

Tukey-Kramer procedure:

* Resort/Cottage: Absolute difference (2.385833) > Critical range (1.472427). Means are different.
* Resort/Classic: Absolute difference (1.192292) < Critical range (1.472427). Means are not different.
* Cottage/Classic: Absolute difference (1.193542) < Critical range (1.472427). Means are not different.

**There is a price difference between Resort and Cottage, so there is a price difference between the brands.**

## Issue 3: Determine whether price differentiation exists between states among the accommodation brands.

### My hypothesis

From the data previously collected, I can observe that the difference between the average prices of hotels situated in different states is negligible. Therefore, I can assume that there are no price differences between states.

We will verify this hypothesis through statistical tests.

### Action Plan

1. **Sort the data by brand and state, copy and restructure the data into three columns (brand), and 48 rows (state).**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Brand 1 | Brand 2 | Brand 3 |
| NSW | 195.00 | 197.63 | 196.11 |
| NSW | 195.71 | 199.18 | 196.22 |
| NSW | 198.21 | 200.91 | 196.86 |
| NSW | 198.29 | 200.93 | 197.16 |
| NSW | 198.88 | 201.08 | 198.49 |
| NSW | 198.98 | 201.75 | 200.11 |
| NSW | 199.13 | 201.83 | 200.63 |
| NSW | 199.18 | 202.22 | 201.02 |
| NSW | 199.21 | 202.55 | 201.89 |
| NSW | 199.25 | 202.82 | 201.96 |
| NSW | 199.43 | 203.03 | 202.73 |
| NSW | 199.61 | 203.17 | 205.52 |
| NSW | 200.20 | 203.69 | 205.62 |
| NSW | 201.66 | 204.05 | 205.93 |
| NSW | 202.58 | 204.10 | 207.45 |
| NSW | 203.02 | 204.51 | 209.65 |
| QLD | 198.58 | 198.43 | 198.66 |
| QLD | 199.05 | 198.58 | 198.85 |
| QLD | 199.20 | 198.62 | 198.90 |
| QLD | 199.45 | 200.71 | 198.92 |
| QLD | 199.49 | 201.17 | 199.18 |
| QLD | 199.71 | 201.47 | 199.31 |
| QLD | 199.87 | 201.77 | 199.45 |
| QLD | 199.92 | 202.31 | 200.72 |
| QLD | 199.99 | 202.53 | 201.39 |
| QLD | 200.64 | 203.19 | 201.83 |
| QLD | 200.84 | 204.49 | 202.17 |
| QLD | 202.07 | 208.79 | 203.25 |
| QLD | 204.08 | 208.79 | 203.56 |
| QLD | 204.69 | 209.06 | 204.69 |
| QLD | 205.99 | 209.95 | 206.15 |
| QLD | 206.12 | 210.57 | 208.30 |
| VIC | 195.66 | 198.14 | 196.84 |
| VIC | 195.77 | 198.43 | 197.78 |
| VIC | 197.84 | 198.60 | 198.20 |
| VIC | 198.36 | 198.67 | 198.28 |
| VIC | 199.16 | 201.27 | 198.58 |
| VIC | 199.18 | 202.65 | 200.67 |
| VIC | 199.38 | 202.74 | 200.86 |
| VIC | 199.55 | 202.76 | 200.90 |
| VIC | 199.55 | 202.83 | 200.97 |
| VIC | 200.26 | 202.88 | 201.37 |
| VIC | 200.58 | 202.94 | 201.46 |
| VIC | 200.65 | 203.31 | 201.86 |
| VIC | 202.49 | 203.48 | 202.02 |
| VIC | 202.50 | 203.79 | 202.32 |
| VIC | 207.01 | 203.93 | 207.01 |
| VIC | 207.01 | 207.20 | 208.41 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for Resort brand

µ2 = average price for Cottage brand

µ3 = average price for Classic brand

h0 column: µ1 = µ2 = µ3

µ1 = average price for NSW State

µ2 = average price for QLD State

µ3 = average price for VIC State

h0 row: µ4 = µ5 = µ6

h0 interaction: There is no interaction between states and brands

**Alternate hypothesis**

h1 column: at least one accommodation brand average price (µ) is different

h1 row: at least one state average price (µ) is different

h1 interaction: There is an interaction between states and brands

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

Reject h0 column if p-value column < α.

Reject h0 row if p-value row < α.

Reject h0 interaction if p-value interaction < α.

1. **Use the Two-Way ANOVA with replication**

The Two-Way ANOVA is used because we want to compare the mean difference between groups that have been split into two factors: The brand and the state.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Anova: Two-Factor With Replication** | | | |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY | Brand 1 | Brand 2 | Brand 3 | Total |  |  |
| *NSW* |  |  |  |  |  |  |
| Count | 16 | 16 | 16 | 48 |  |  |
| Sum | 3188.34 | 3233.45 | 3227.35 | 9649.14 |  |  |
| Average | 199.2713 | 202.0906 | 201.7094 | 201.0238 |  |  |
| Variance | 4.333012 | 3.427366 | 17.66901 | 9.708803 |  |  |
|  |  |  |  |  |  |  |
| *QLD* |  |  |  |  |  |  |
| Count | 16 | 16 | 16 | 48 |  |  |
| Sum | 3219.69 | 3260.43 | 3225.33 | 9705.45 |  |  |
| Average | 201.2306 | 203.7769 | 201.5831 | 202.1969 |  |  |
| Variance | 6.491673 | 18.31522 | 8.619863 | 11.96402 |  |  |
|  |  |  |  |  |  |  |
| *VIC* |  |  |  |  |  |  |
| Count | 16 | 16 | 16 | 48 |  |  |
| Sum | 3204.95 | 3233.62 | 3217.53 | 9656.1 |  |  |
| Average | 200.3094 | 202.1013 | 201.0956 | 201.1688 |  |  |
| Variance | 10.41843 | 6.162158 | 9.5774 | 8.897547 |  |  |
|  |  |  |  |  |  |  |
| *Total* |  |  |  |  |  |  |
| Count | 48 | 48 | 48 |  |  |  |
| Sum | 9612.98 | 9727.5 | 9670.21 |  |  |  |
| Average | 200.2704 | 202.6563 | 201.4627 |  |  |  |
| Variance | 7.433966 | 9.547049 | 11.5182 |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Sample | 39.26861 | 2 | 19.63431 | 2.078581 | 0.129093 | 3.063204 |
| Columns | 136.6128 | 2 | 68.30641 | 7.231241 | 0.001039 | 3.063204 |
| Interaction | 24.98265 | 4 | 6.245661 | 0.661195 | 0.620017 | 2.438739 |
| Within | 1275.212 | 135 | 9.446015 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 1476.076 | 143 |  |  |  |  |

### Results

Row: p-value (0.129093) > 0.05, h0 is not rejected.

**The price difference between states is negligible or nil.**

Column: p-value (0.001039) < 0.05, h0 is rejected.

**There is a price difference between brands.**

Interaction: p-value (0.620017) > 0.05, h0 is not rejected.

**There are no interactions between brands and states.**

## Issue 4: Determine whether price differentiation exists between locations among the accommodation brands.

### My hypothesis

From the data previously collected, I can observe that the difference between the average prices of hotels situated in different locations is negligible. Therefore, I can assume that there are no price differences between locations.

We will verify this hypothesis through statistical tests.

### Action Plan

1. **Sort the data by brand and location, copy and restructure the data into three columns (brand), and 48 rows (location).**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Brand 1 | Brand 2 | Brand 3 |
| Metropolitan Cities | 198.29 | 197.63 | 201.02 |
| Metropolitan Cities | 198.88 | 199.18 | 201.96 |
| Metropolitan Cities | 198.98 | 200.93 | 202.73 |
| Metropolitan Cities | 199.21 | 202.22 | 205.52 |
| Metropolitan Cities | 200.20 | 203.03 | 205.62 |
| Metropolitan Cities | 198.58 | 203.69 | 205.93 |
| Metropolitan Cities | 199.05 | 204.05 | 207.45 |
| Metropolitan Cities | 199.20 | 204.51 | 198.66 |
| Metropolitan Cities | 199.49 | 198.43 | 198.85 |
| Metropolitan Cities | 199.71 | 198.58 | 198.90 |
| Metropolitan Cities | 199.87 | 198.62 | 199.31 |
| Metropolitan Cities | 199.92 | 202.31 | 201.39 |
| Metropolitan Cities | 200.64 | 202.53 | 201.83 |
| Metropolitan Cities | 200.84 | 204.49 | 204.69 |
| Metropolitan Cities | 202.07 | 209.06 | 208.30 |
| Metropolitan Cities | 204.69 | 209.95 | 196.84 |
| Metropolitan Cities | 195.66 | 198.14 | 197.78 |
| Metropolitan Cities | 195.77 | 198.43 | 198.58 |
| Metropolitan Cities | 199.16 | 198.60 | 200.67 |
| Metropolitan Cities | 199.38 | 202.74 | 200.86 |
| Metropolitan Cities | 199.55 | 202.83 | 200.90 |
| Metropolitan Cities | 199.55 | 202.94 | 202.32 |
| Metropolitan Cities | 207.01 | 203.93 | 207.01 |
| Metropolitan Cities | 207.01 | 207.20 | 208.41 |
| Regional Cities | 195.00 | 200.91 | 196.11 |
| Regional Cities | 195.71 | 201.08 | 196.22 |
| Regional Cities | 198.21 | 201.75 | 196.86 |
| Regional Cities | 199.13 | 201.83 | 197.16 |
| Regional Cities | 199.18 | 202.55 | 198.49 |
| Regional Cities | 199.25 | 202.82 | 200.11 |
| Regional Cities | 199.43 | 203.17 | 200.63 |
| Regional Cities | 199.61 | 204.10 | 201.89 |
| Regional Cities | 201.66 | 200.71 | 209.65 |
| Regional Cities | 202.58 | 201.17 | 198.92 |
| Regional Cities | 203.02 | 201.47 | 199.18 |
| Regional Cities | 199.45 | 201.77 | 199.45 |
| Regional Cities | 199.99 | 203.19 | 200.72 |
| Regional Cities | 204.08 | 208.79 | 202.17 |
| Regional Cities | 205.99 | 208.79 | 203.25 |
| Regional Cities | 206.12 | 210.57 | 203.56 |
| Regional Cities | 197.84 | 198.67 | 206.15 |
| Regional Cities | 198.36 | 201.27 | 198.20 |
| Regional Cities | 199.18 | 202.65 | 198.28 |
| Regional Cities | 200.26 | 202.76 | 200.97 |
| Regional Cities | 200.58 | 202.88 | 201.37 |
| Regional Cities | 200.65 | 203.31 | 201.46 |
| Regional Cities | 202.49 | 203.48 | 201.86 |
| Regional Cities | 202.50 | 203.79 | 202.02 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for Resort brand

µ2 = average price for Cottage brand

µ3 = average price for Classic brand

h0 column: µ1 = µ2 = µ3

µ1 = average price for Metropolitan Cities

µ2 = average price for Regional Cities

h0 row: µ1 = µ2

h0 interaction: There is no interaction between locations and brands

**Alternate hypothesis**

h1 column: at least one accommodation brand average price (µ) is different

h1 row: at least one location average price (µ) is different

h1 interaction: There is an interaction between locations and brands

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

Reject h0 column if p-value column < α.

Reject h0 row if p-value row < α.

Reject h0 interaction if p-value interaction < α.

1. **Use the Two-Way ANOVA with replication**

The Two-Way ANOVA is used because we want to compare the mean difference between groups that have been split into two factors: The brand and the state.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Anova: Two-Factor With Replication** | | | |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY | Brand 1 | Brand 2 | Brand 3 | Total |  |  |
| *Metropolitan Cities* |  |  |  |  |  |  |
| Count | 24 | 24 | 24 | 72 |  |  |
| Sum | 4802.71 | 4854.02 | 4855.53 | 14512.26 |  |  |
| Average | 200.1129 | 202.2508 | 202.3138 | 201.5592 |  |  |
| Variance | 7.539274 | 11.68394 | 12.24893 | 11.25642 |  |  |
|  |  |  |  |  |  |  |
| *Regional Cities* |  |  |  |  |  |  |
| Count | 24 | 24 | 24 | 72 |  |  |
| Sum | 4810.27 | 4873.48 | 4814.68 | 14498.43 |  |  |
| Average | 200.4279 | 203.0617 | 200.6117 | 201.3671 |  |  |
| Variance | 7.600104 | 7.482232 | 9.776745 | 9.514677 |  |  |
|  |  |  |  |  |  |  |
| *Total* |  |  |  |  |  |  |
| Count | 48 | 48 | 48 |  |  |  |
| Sum | 9612.98 | 9727.5 | 9670.21 |  |  |  |
| Average | 200.2704 | 202.6563 | 201.4627 |  |  |  |
| Variance | 7.433966 | 9.547049 | 11.5182 |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Sample | 1.328256 | 1 | 1.328256 | 0.141476 | 0.707395 | 3.909729 |
| Columns | 136.6128 | 2 | 68.30641 | 7.275512 | 0.000991 | 3.061716 |
| Interaction | 42.5169 | 2 | 21.25845 | 2.264299 | 0.10775 | 3.061716 |
| Within | 1295.618 | 138 | 9.388537 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 1476.076 | 143 |  |  |  |  |

### Results

Row: p-value (0.707395) > 0.05, h0 is not rejected.

**The price difference between locations is negligible or nil.**

Column: p-value (0.000991) < 0.05, h0 is rejected.

**There is a price difference between brands.**

Interaction: p-value (0.10775) > 0.05, h0 is not rejected.

**There are no interactions between brands and locations.**

## Issue 5: Determine if the introduction of the Comfort brand has increased internal competition among the other accommodation brands.

### My hypothesis

To make this hypothesis, we need to rearrange our pivot table first:

|  |  |  |  |
| --- | --- | --- | --- |
| **Average Price** | **Column Labels** |  |  |
| **Comfort** | **Resort** | **Cottage** | **Classic** |
| Yes | 198.57125 | 201.695 | 199.559375 |
| No | 201.009375 | 202.496875 | 203.245625 |
|  | 200.6871429 | 203.2925 | 201.945 |
|  | 205.035 | 206.4833333 | 199.05 |
|  |  | 201.47 |  |
| **Grand Total** | **200.2704167** | **202.65625** | **201.4627083** |

From the data collected above, I can observe that within the same brand, the difference between the average prices of hotels with comfort, and hotels of the same brand without comfort, is negligible. Therefore, I can assume that within the same brand, there are no price differences between hotels with comfort, and hotels without comfort.

We will verify this hypothesis through statistical tests.

### 

### Action Plan

1. **Sort the data by brand and comfort, copy and restructure the data into three columns (brand), and 48 rows (location). Delete all the rows which do not have a “comfort” characteristic.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Resort | Cottage | Classic |
| Comfort | 198.98 | 199.18 | 196.84 |
| Comfort | 199.21 | 198.14 | 197.78 |
| Comfort | 200.20 | 198.43 | 198.58 |
| Comfort | 195.66 | 198.60 | 200.67 |
| Comfort | 199.16 | 203.93 | 200.86 |
| Comfort | 199.38 | 207.20 | 200.90 |
| Comfort | 199.55 | 201.08 | 202.32 |
| Comfort | 199.55 | 201.75 | 208.41 |
| Comfort | 195.00 | 198.67 | 196.11 |
| Comfort | 195.71 | 201.27 | 196.22 |
| Comfort | 198.21 | 202.65 | 196.86 |
| Comfort | 199.13 | 202.76 | 198.49 |
| Comfort | 199.18 | 202.88 | 198.20 |
| Comfort | 199.43 | 203.31 | 198.28 |
| Comfort | 199.61 | 203.48 | 200.97 |
| Comfort | 199.18 | 203.79 | 201.46 |
| No Comfort | 198.29 | 197.63 | 201.02 |
| No Comfort | 198.88 | 200.93 | 201.96 |
| No Comfort | 195.77 | 202.22 | 202.73 |
| No Comfort | 207.01 | 203.03 | 205.52 |
| No Comfort | 207.01 | 203.69 | 205.62 |
| No Comfort | 199.25 | 204.05 | 205.93 |
| No Comfort | 201.66 | 204.51 | 207.45 |
| No Comfort | 202.58 | 202.74 | 207.01 |
| No Comfort | 203.02 | 202.83 | 197.16 |
| No Comfort | 197.84 | 202.94 | 200.11 |
| No Comfort | 198.36 | 200.91 | 200.63 |
| No Comfort | 200.26 | 201.83 | 201.89 |
| No Comfort | 200.58 | 202.55 | 209.65 |
| No Comfort | 200.65 | 202.82 | 201.37 |
| No Comfort | 202.49 | 203.17 | 201.86 |
| No Comfort | 202.50 | 204.10 | 202.02 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for Resort brand

µ2 = average price for Cottage brand

µ3 = average price for Classic brand

h0 column: µ1 = µ2 = µ3

µ1 = average price for Accommodation with comfort

µ2 = average price for Accommodation without comfort

h0 row: µ1 = µ2

h0 interaction: There is no interaction between locations and brands

**Alternate hypothesis**

h1 column: at least one accommodation brand average price (µ) is different

h1 row: at least one comfort average price (µ) is different

h1 interaction: There is an interaction between comfort and brands

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

Reject h0 column if p-value column < α.

Reject h0 row if p-value row < α.

Reject h0 interaction if p-value interaction < α.

1. **Use the Two-Way ANOVA with replication**

The Two-Way ANOVA is used because we want to compare the mean difference between groups that have been split into two factors: The brand and the comfort.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Anova: Two-Factor With Replication** | | |  |  |  |  |
|  |  |  |  |  |  |  |
| SUMMARY | Resort | Cottage | Classic | Total |  |  |
| *Comfort* |  |  |  |  |  |  |
| Count | 16 | 16 | 16 | 48 |  |  |
| Sum | 3177.14 | 3227.12 | 3192.95 | 9597.21 |  |  |
| Average | 198.57125 | 201.695 | 199.559375 | 199.941875 |  |  |
| Variance | 2.570718333 | 6.52328 | 9.51760625 | 7.675487899 |  |  |
|  |  |  |  |  |  |  |
| *No Comfort* |  |  |  |  |  |  |
| Count | 16 | 16 | 16 | 48 |  |  |
| Sum | 3216.15 | 3239.95 | 3251.93 | 9708.03 |  |  |
| Average | 201.009375 | 202.496875 | 203.245625 | 202.250625 |  |  |
| Variance | 9.58512625 | 2.723369583 | 10.68253292 | 8.219729388 |  |  |
|  |  |  |  |  |  |  |
| *Total* |  |  |  |  |  |  |
| Count | 32 | 32 | 32 |  |  |  |
| Sum | 6393.29 | 6467.07 | 6444.88 |  |  |  |
| Average | 199.7903125 | 202.0959375 | 201.4025 |  |  |  |
| Variance | 7.415912802 | 4.640121673 | 13.28095484 |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| ANOVA |  |  |  |  |  |  |
| *Source of Variation* | *SS* | *df* | *MS* | *F* | *P-value* | *F crit* |
| Sample | 127.9278375 | 1 | 127.9278375 | 18.4499625 | 4.39753E-05 | 3.946875731 |
| Columns | 89.55638125 | 2 | 44.77819063 | 6.45798408 | 0.002394355 | 3.097698035 |
| Interaction | 33.47933125 | 2 | 16.73966562 | 2.414222026 | 0.095208301 | 3.097698035 |
| Within | 624.0395 | 90 | 6.933772222 |  |  |  |
|  |  |  |  |  |  |  |
| Total | 875.00305 | 95 |  |  |  |  |

### Results

Row: p-value (0.0000439753) < 0.05, h0 is rejected.

**There is a price difference between comfort / no comfort.**

Column: p-value (0.002394355) < 0.05, h0 is rejected.

**There is a price difference between brands.**

Interaction: p-value (0.095208301) > 0.05, h0 is not rejected.

**There are no interactions between brands and comfort.**

We now know that the comfort characteristic has an influence on the price.

We need to perform tests on every brand.

##### **The Resort brand**

1. **Sort the data by brand and comfort, copy only the “Resort” hotels data, and restructure the data into two columns by brand comfort.**

|  |  |
| --- | --- |
| Resort with comfort | Resort without comfort |
| 198.98 | 198.29 |
| 199.21 | 198.88 |
| 200.20 | 195.77 |
| 195.66 | 207.01 |
| 199.16 | 207.01 |
| 199.38 | 199.25 |
| 199.55 | 201.66 |
| 199.55 | 202.58 |
| 195.00 | 203.02 |
| 195.71 | 197.84 |
| 198.21 | 198.36 |
| 199.13 | 200.26 |
| 199.18 | 200.58 |
| 199.43 | 200.65 |
| 199.61 | 202.49 |
| 199.18 | 202.50 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for resort with comfort

µ2 = average price for resort without comfort

h0: µ1 >= µ2 or h0: µ1 - µ2 >= 0

**Alternate hypothesis**

h1: μ1 < μ2 or h1: µ1 - µ2 < 0

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

t-test:

* If p-value one-tail < α, Reject h0.
* If t Stat < t Critical one-tail, Reject h0.

Z-test:

* If p-value one-tail < α, Reject h0.
* If Z < z Critical one-tail, Reject h0.

1. **Use the t-test and z-test**

We use the t-test and z-test because we need a one-tailed test to determine if there’s a difference between groups (comfort / without comfort) in a specific direction.

|  |  |  |
| --- | --- | --- |
| **t-Test: Two-Sample Assuming Unequal Variances** | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 198.57125 | 201.009375 |
| Variance | 2.570718333 | 9.58512625 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| Df | 23 |  |
| t Stat | -2.797199163 |  |
| P(T<=t) one-tail | 0.005117843 |  |
| t Critical one-tail | 1.713871528 |  |
| P(T<=t) two-tail | 0.010235686 |  |
| t Critical two-tail | 2.06865761 |  |

To do the z-Test, we need the variances of the samples. We can either obtain it in the t-Test result above or with the VAR.S excel command.

|  |  |
| --- | --- |
| Comfort VAR.S | No comfort VAR.S |
| 2.570718333 | 9.58512625 |

|  |  |  |
| --- | --- | --- |
| **z-Test: Two Sample for Means** | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 198.57125 | 201.009375 |
| Known Variance | 2.57071833 | 9.58512625 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| Z | -2.7971992 |  |
| P(Z<=z) one-tail | 0.00257739 |  |
| z Critical one-tail | 1.64485363 |  |
| P(Z<=z) two-tail | 0.00515477 |  |
| z Critical two-tail | 1.95996398 |  |

### Resort results

t-test:

* p-value one-tail (0.005117843) < α (0.05), h0 is rejected.
* t Stat (-2.797199163) < t Critical one-tail (1.713871528), h0 is rejected.

z-test:

* p-value one-tail (0.00257739) < α (0.05), h0 is rejected.
* Z (-2.7971992) < z Critical one-tail (1.614485363), h0 is rejected.

**There is a price difference between Resort with comfort and Resort without comfort.**

**The price of a Resort with comfort is lower than the price of Resort without comfort.**

##### **The Cottage brand**

1. **Sort the data by brand and comfort, copy only the “Cottage” hotels data, and restructure the data into two columns by brand comfort.**

|  |  |
| --- | --- |
| Cottage with comfort | Cottage without comfort |
| 199.18 | 197.63 |
| 198.14 | 200.93 |
| 198.43 | 202.22 |
| 198.60 | 203.03 |
| 203.93 | 203.69 |
| 207.20 | 204.05 |
| 201.08 | 204.51 |
| 201.75 | 202.74 |
| 198.67 | 202.83 |
| 201.27 | 202.94 |
| 202.65 | 200.91 |
| 202.76 | 201.83 |
| 202.88 | 202.55 |
| 203.31 | 202.82 |
| 203.48 | 203.17 |
| 203.79 | 204.10 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for cottage with comfort

µ2 = average price for cottage without comfort

h0: µ1 >= µ2 or h0: µ1 - µ2 >= 0

**Alternate hypothesis**

h1: μ1 < μ2 or h1: µ1 - µ2 < 0

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

t-test:

* If p-value one-tail < α, Reject h0.
* If t Stat < t Critical one-tail, Reject h0.

Z-test:

* If p-value one-tail < α, Reject h0.
* If Z < z Critical one-tail, Reject h0

1. **Use the t-test and z-test**

We use the t-test and z-test because we need a one-tailed test to determine if there’s a difference between groups (comfort / without comfort) in a specific direction.

|  |  |  |
| --- | --- | --- |
| **t-Test: Two-Sample Assuming Unequal Variances** | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 201.695 | 202.4969 |
| Variance | 6.52328 | 2.72337 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| df | 26 |  |
| t Stat | -1.054810551 |  |
| P(T<=t) one-tail | 0.150607898 |  |
| t Critical one-tail | 1.70561792 |  |
| P(T<=t) two-tail | 0.301215795 |  |
| t Critical two-tail | 2.055529439 |  |

To do the z-Test, we need the variances of the samples. We can either obtain it in the t-Test result above or with the VAR.S excel command.

|  |  |
| --- | --- |
| comfort VAR.S | no comfort VAR.S |
| 6.52328 | 2.723369583 |

|  |  |  |
| --- | --- | --- |
| **z-Test: Two Sample for Means** | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 201.695 | 202.496875 |
| Known Variance | 6.52328 | 2.72337 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| z | -1.05481053 |  |
| P(Z<=z) one-tail | 0.14575599 |  |
| z Critical one-tail | 1.64485363 |  |
| P(Z<=z) two-tail | 0.29151199 |  |
| z Critical two-tail | 1.95996398 |  |

### Cottage results

t-test:

* p-value one-tail (0.150607898) > α (0.05), h0 is not rejected.
* t Stat (-1.054810551) < t Critical one-tail (1.70561792), h0 is rejected.

z-test:

* p-value one-tail (0.14575599) > α (0.05), h0 is not rejected.
* Z (-1.05481053) < z Critical one-tail (1.64485363), h0 is rejected.

**The price difference between Cottage with comfort and Cottage without comfort is negligible.**

**However, the price of Cottage with comfort is slightly lower than the price of Cottage without comfort.**

##### **The Classic brand**

1. **Sort the data by brand and comfort, copy only the “Classic” hotels data, and restructure the data into two columns by brand comfort.**

|  |  |
| --- | --- |
| Classic with comfort | Classic without comfort |
| 196.84 | 201.02 |
| 197.78 | 201.96 |
| 198.58 | 202.73 |
| 200.67 | 205.52 |
| 200.86 | 205.62 |
| 200.90 | 205.93 |
| 202.32 | 207.45 |
| 208.41 | 207.01 |
| 196.11 | 197.16 |
| 196.22 | 200.11 |
| 196.86 | 200.63 |
| 198.49 | 201.89 |
| 198.20 | 209.65 |
| 198.28 | 201.37 |
| 200.97 | 201.86 |
| 201.46 | 202.02 |

1. **Hypothesis testing procedure**

**Null hypothesis**

µ1 = average price for classic with comfort

µ2 = average price for classic without comfort

h0: µ1 >= µ2 or h0: µ1 - µ2 >= 0

**Alternate hypothesis**

h1: μ1 < μ2 or h1: µ1 - µ2 < 0

**Alpha level**

Level of significance (α) = 0.05

**Rejection region**

t-test:

* If p-value one-tail < α, Reject h0.
* If t Stat < t Critical one-tail, Reject h0.

Z-test:

* If p-value one-tail < α, Reject h0.
* If Z < z Critical one-tail, Reject h0

1. **Use the t-test and z-test**

We use the t-test and z-test because we need a one-tailed test to determine if there’s a difference between groups (comfort / without comfort) in a specific direction.

|  |  |  |
| --- | --- | --- |
| t-Test: Two-Sample Assuming Unequal Variances | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 199.559375 | 203.245625 |
| Variance | 9.51760625 | 10.68253292 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| df | 30 |  |
| t Stat | -3.2807081 |  |
| P(T<=t) one-tail | 0.001314 |  |
| t Critical one-tail | 1.69726089 |  |
| P(T<=t) two-tail | 0.00262799 |  |
| t Critical two-tail | 2.04227246 |  |

To do the z-Test, we need the variances of the samples. We can either obtain it in the t-Test result above or with the VAR.S excel command.

|  |  |
| --- | --- |
| comfort VAR.S | no comfort VAR.S |
| 9.51760625 | 10.68253292 |

|  |  |  |
| --- | --- | --- |
| z-Test: Two Sample for Means | | |
|  |  |  |
|  | *With comfort* | *Without comfort* |
| Mean | 199.559375 | 203.245625 |
| Known Variance | 9.51760625 | 10.68253292 |
| Observations | 16 | 16 |
| Hypothesized Mean Difference | 0 |  |
| z | -3.28070814 |  |
| P(Z<=z) one-tail | 0.000517734 |  |
| z Critical one-tail | 1.644853627 |  |
| P(Z<=z) two-tail | 0.001035468 |  |
| z Critical two-tail | 1.959963985 |  |

### Classic results

t-test:

* p-value one-tail (0.001314) < α (0.05), h0 is rejected.
* t Stat (-3.2807081) < t Critical one-tail (1.69726089), h0 is rejected.

z-test:

* p-value one-tail (0.000517734) < α (0.05), h0 is rejected.
* Z (-3.28070814) < z Critical one-tail (1.644853627), h0 is rejected.

**There is a price difference between Classic with comfort and Classic without comfort.**

**The price of Classic with comfort is lower than the price of Classic without comfort.**

### Global results

**The introduction of the comfort brand has increased internal competition in the Resort and Classic brands, but not in the Cottage brand.**