Problem Statement

TeleCall uses 4 centers around the globe to process customer order forms. They audit a certain % of the customer order forms. Any error in order form renders it defective and has to be reworked before processing. The manager wants to check whether the defective % varies by centre. Please analyze the data at 5% significance level and help the manager draw appropriate inferences

1. Understanding Business Problem

To identify whether defective % varies within 4 centers

2. Given Data

Level of Significance → α = 0.05 (5% level of Significance, in other words 95% level of Confidence)

3. Import Necessary Libraries

In [41]:
```
import pandas as pd
from scipy.stats import chi2_contingency
from matplotlib import pyplot as plt
import seaborn as sns
import numpy as np

import warnings
warnings.filterwarnings('ignore')
```

4. Import Data

In [3]:
```
customer_order_form = pd.read_csv('CostomerOrderForm.csv')
customer_order_form.head()
```

Out[3]:

	Phillippines	Indonesia	Malta	India
0	Error Free	Error Free	Defective	Error Free
1	Error Free	Error Free	Error Free	Defective
2	Error Free	Defective	Defective	Error Free
3	Error Free	Error Free	Error Free	Error Free
4	Error Free	Error Free	Defective	Error Free

In [4]:
```
customer_order_form.tail()
```

Out[4]:

	Phillippines	Indonesia	Malta	India
295	Error Free	Error Free	Error Free	Error Free
296	Error Free	Error Free	Error Free	Error Free
297	Error Free	Error Free	Defective	Error Free
298	Error Free	Error Free	Error Free	Error Free
299	Error Free	Defective	Defective	Error Free

In [5]:
```
type(customer_order_form)
```

Out[5]:
```
pandas.core.frame.DataFrame
```

In [6]:
```
# How to show head() and tail() together
```

In [7]:
```
pd.concat([customer_order_form.head(),customer_order_form.tail()],axis=1)
```

Out[7]:

	Phillippines	Indonesia	Malta	India	Phillippines	Indonesia	Malta	India
0	Error Free	Error Free	Defective	Error Free	NaN	NaN	NaN	NaN
1	Error Free	Error Free	Error Free	Defective	NaN	NaN	NaN	NaN
2	Error Free	Defective	Defective	Error Free	NaN	NaN	NaN	NaN
3	Error Free	Error Free	Error Free	Error Free	NaN	NaN	NaN	NaN
4	Error Free	Error Free	Defective	Error Free	NaN	NaN	NaN	NaN
295	NaN	NaN	NaN	NaN	Error Free	Error Free	Error Free	Error Free
296	NaN	NaN	NaN	NaN	Error Free	Error Free	Error Free	Error Free
297	NaN	NaN	NaN	NaN	Error Free	Error Free	Defective	Error Free
298	NaN	NaN	NaN	NaN	Error Free	Error Free	Error Free	Error Free
299	NaN	NaN	NaN	NaN	Error Free	Defective	Defective	Error Free

How to show head() and tail() of a datased together side by side?

In [8]:
```
from IPython.display import display_html
from itertools import chain,cycle
def display_side_by_side(*args,titles=cycle([''])):
    html_str=''
    for df,title in zip(args, chain(titles,cycle(['</br>'])) ):
        html_str+='<th style="text-align:center"><td style="vertical-align:top">'
        html_str+=f'<h2>{title}</h2>'
        html_str+=df.to_html().replace('table','table style="display:inline"')
        html_str+='</td></th>'
    display_html(html_str,raw=True)
```

In [9]:
```
display_side_by_side(customer_order_form.head(),customer_order_form.tail(),titles=['Head','Tail'])
```

Head

	Phillippines	Indonesia	Malta	India
0	Error Free	Error Free	Defective	Error Free
1	Error Free	Error Free	Error Free	Defective
2	Error Free	Defective	Defective	Error Free
3	Error Free	Error Free	Error Free	Error Free
4	Error Free	Error Free	Defective	Error Free

Tail

	Phillippines	Indonesia	Malta	India
295	Error Free	Error Free	Error Free	Error Free
296	Error Free	Error Free	Error Free	Error Free
297	Error Free	Error Free	Defective	Error Free
298	Error Free	Error Free	Error Free	Error Free
299	Error Free	Defective	Defective	Error Free

5. Data Understanding

In [10]:
```
customer_order_form.shape
```

Out[10]:
```
(300, 4)
```

In [11]:
```
customer_order_form.dtypes
```

Out[11]:
```
Phillippines    object
Indonesia       object
Malta           object
India           object
dtype: object
```

In [12]:
```
customer_order_form.describe(include='all')
```

Out[12]:

	Phillippines	Indonesia	Malta	India
count	300	300	300	300
unique	2	2	2	2
top	Error Free	Error Free	Error Free	Error Free
freq	271	267	269	280

In [13]:
```
col = list(customer_order_form)
col
```

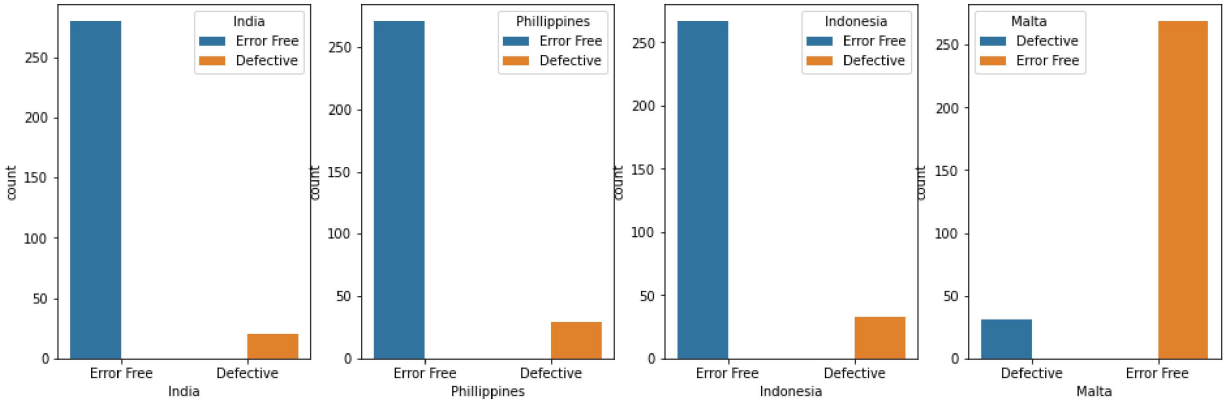
Out[13]:
```
['Phillippines', 'Indonesia', 'Malta', 'India']
```

In [14]:
```
plt.figure(figsize=(16,5))
plt.subplot(1,4,1)
sns.countplot('India', hue= 'India', data=customer_order_form)

plt.subplot(1,4,2)
sns.countplot('Phillippines', hue= 'Phillippines', data=customer_order_form)

plt.subplot(1,4,3)
sns.countplot('Indonesia', hue= 'Indonesia', data=customer_order_form)

plt.subplot(1,4,4)
sns.countplot('Malta', hue= 'Malta', data=customer_order_form)
plt.show()
```



6. Hypothesis Formulation

H0 = Defective % does not varies within 4 centers.
Ha = Defective % varies within 4 centers.
α = 0.05

7. Perform Hypothesis Testing

Since there are more than 2 variables, we will perform 'Chi-Square test'

In [37]:
```
chi2,p_val_orders,dof_orders,expected_orders = chi2_contingency([customer_order_form['Phillippines'].value_counts(),
                                                                 customer_order_form['Indonesia'].value_counts(),
                                                                 customer_order_form['Malta'].value_counts(),
                                                                 customer_order_form['India'].value_counts(),])
```

In [40]:
```
print('Chi-Square test   :',chi2)
print('P-value           :',p_val_orders)
print('Degrees of Freedom:',dof_orders)
print('Expected Array    :\n',expected_orders)
```

```
Chi-Square test   : 3.8589606858203545
P-value           : 0.2771020991233144
Degrees of Freedom: 3
Expected Array    :
 [[271.75  28.25]
 [271.75  28.25]
 [271.75  28.25]
 [271.75  28.25]]
```

8. Conclusion

In [29]:
```
# checking if 'α > P-value' or 'α < P-value'
```

In [30]:
```
if p_val_orders > 0.05:
    print('At 5% level of significance, we cannot reject the Null Hypothesis and we can say that defective % does not varies wit
else:
    print('At 5% level of significance, we can reject the Null Hypothesis and we can say that defective % varies within 4 center
```

```
At 5% level of significance, we cannot reject the Null Hypothesis and we can say that defective % does not varies within 4 cent
ers.
```

9. Verifying the above conclusion manually

In [15]:
```
customer_order_form['India'].value_counts()
```

Out[15]:
```
Error Free    280
Defective      20
Name: India, dtype: int64
```

In [16]:
```
round((20*100/280),4)
```

Out[16]:
```
7.1429
```

In [17]:
```
customer_order_form['Phillippines'].value_counts()
```

Out[17]:
```
Error Free    271
Defective      29
Name: Phillippines, dtype: int64
```

In [18]:
```
round((29*100/271),4)
```

Out[18]:
```
10.7011
```

In [19]:
```
customer_order_form['Indonesia'].value_counts()
```

Out[19]:
```
Error Free    267
Defective      33
Name: Indonesia, dtype: int64
```

In [20]:
```
round((33*100/267),4)
```

Out[20]:
```
12.3596
```

In [21]:
```
customer_order_form['Malta'].value_counts()
```

Out[21]:
```
Error Free    269
Defective      31
Name: Malta, dtype: int64
```

In [22]:
```
round((31*100/269),4)
```

Out[22]:
```
11.5242
```