University of Exeter coursework header sheet

BEMM460J Statistics and Mathematics for Business Analytics (A, TERM2 2021/2)

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Coursework: Mid-term exam - Option 2

Submission Deadline: Tue 1st Mar 2022 03:00

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BEMM 460J - Statistics and Mathematics for Business Analytics

Date : 28th Feb 2021

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Midterm Exam

Ans 1 I) Data :

30, 20, 30, 20, 40, 50, 20, 30, 10, 20, 40, 60, 20, 30, 50

Ascending Order:

1	10	→ Minimum
2	20	
3	20	
4	20	→ Q_1
5	20	
6	20	
7	30	
8	30	→ Median.
9	30	
10	30	
11	40	
12	40	→ Q_3
13	50	
14	50	
15	60	→ Maximum

Mean = $\frac{\text{Total Sum of observations}}{\text{No. of observations}}$

$= \frac{470}{15}$

$= \boxed{31.33}$

Frequency table

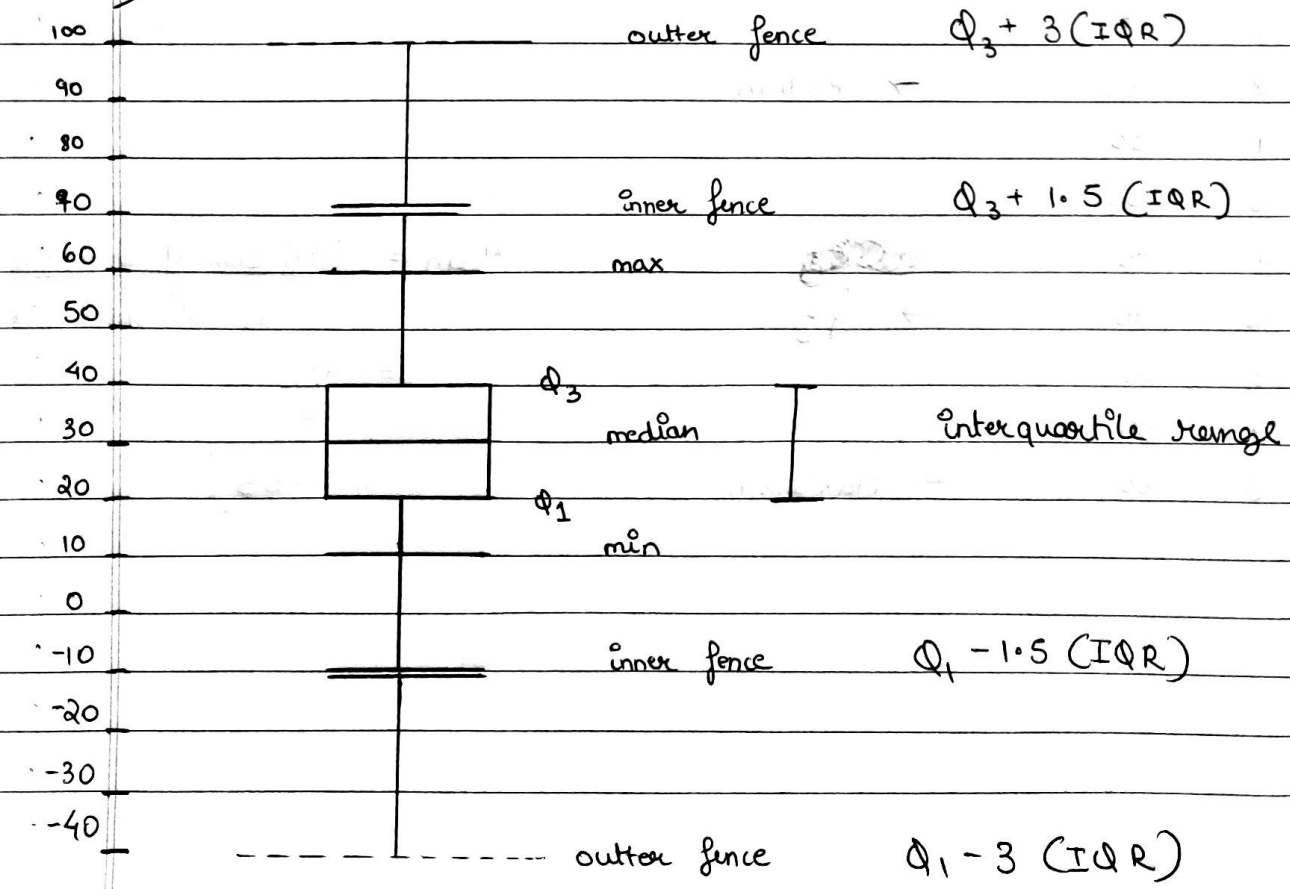
data	Frequency
10	1
20	5
30	4
40	2
50	2
60	1

→ Mode

Mode = 20

Ans I Mean = 31.33
Median = 30
Mode = 20
Max = 60
Min = 10

Ans II) Box Plot

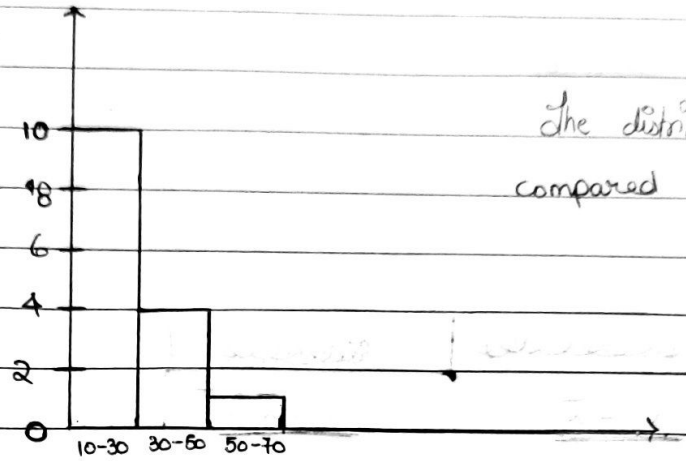


Histogram

10 - 30 ⇒ 10

30 - 50 ⇒ 4

50 - 70 ⇒ 1



The distribution is right-skewed compared to a normal distribution.

ns III) → If the value 60 was replaced by 1200 then it will be called an Out lier.

→ An explaination for having such an outlier could be a festival or a promotional activity which led to a sudden influx of data.

→ This value should be excluded from your analysis because it lies outside the outter fence of the Box Plot because it is an unusual value, i.e. "out lier".

ns IV) Replacing 60 with 1200

Mean = $\frac{410 + 1200}{15} = \boxed{107.33}$ → The changes since its average of the total observations.

Median = 30 → This remains same since it's position based

Mode = 20. → This remains same since its frequency based

Ans (V) Standard dev (for sample)

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{N-1}}$$

Coefficient of variation

$$= \frac{\sigma}{\mu}$$

$\bar{x} = 31.33$

Sr No.	data	$x_i - \bar{x}$	$(x_i - \bar{x})^2$
1.	10	-21.33	454.968
2.	20	-11.33	128.368
3.	20	-11.33	128.368
4.	20	-11.33	128.368
5.	20	-11.33	128.368
6.	20	-11.33	128.368
7.	30	-1.33	1.768
8.	30	-1.33	1.768
9.	30	-1.33	1.768
10.	30	-1.33	1.768
11.	40	8.67	75.168
12.	40	8.67	75.168
13.	50	18.67	348.568
14.	50	18.67	348.568
15.	60	28.67	821.968

Total = 2773.334

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{2773.334}{14}} = \sqrt{198.095}$$

$$\boxed{\sigma = 14.074}$$

$$\text{coefficient of variance} = \frac{\sigma}{\mu} = \frac{14.074}{31.33}$$

$$= \frac{14.074}{31.33} = 44.923$$

Standard div = 14.074

coefficient of varaince = 44.923

Ans 2

To understand the advantages and disadvantages of statistical analysis ofbehavioral operations in business and management we first need to understand what each of the terms means.

Statistical analysis means to take quantitative data to determine correlations between two or more variables or to predict future outcomes of possible events occurring in similar circumstances. To achieve this the first step is to **collect data**, which can be done using various methods; online/offline surveys, reviews, online tracking, etc. The next step is to **segment that data into categories**, segmentation helps in setting up the correct variables required to make accurate inferences from the data. The third step is **implementing strategies** by analyzing the data using its business practices to make better business decisions.

Behavioral operations management is the study of human emotions when facing complex decision making problems. It focuses on the operations of the business so that the improvements arrived from the statistical analysis are positively impacting the company. Studying this is necessary because the statistical analysis of popular products, underperforming products, keywords that bring visitors to your site, etc. provides insight into each visitor.

The **advantages** of statistical analysis in behavioral operations management are;
1. To understand **cognitive behavior** i.e. what is happening within the mind when new information is received, how people respond to this information, and how this response affects their behavior and emotions.
2. To determine **social indicators** such as; competition between individuals, why individuals or organizations seek to protect and maintain their status, why there's a will to sacrifice efficiency to achieve their goal of staying at a higher position, goal setting, feedback and controls, interdependence, and reciprocity.
3. To determine the ways people behave when they are **organized in groups**. This can help predict personality, job satisfaction, reward management, leadership, authority, power, and politics.

The **disadvantages/challenges** of statistical analysis in behavioral operations management are;
1. Making a statistical model and inferring the data for behavioral analysis is usually done by different departments or teams within a company. This can lead to **incoherence** between the two departments.

2. The **cost of collecting data** for small businesses is easy but when there are a large number of variables, collection requires a lot more time and money, and its impacts may not be immediate.
3. The **quality of data** that is collected is low, i.e. if data is old, if there are inaccuracies, etc.
4. Due to the high demand for data-driven analysis, there are a lot of companies practicing unethical means for the collection of data. This can lead to **privacy concerns.**
5. Some tools used by companies use logic to analyze data that is not clear and/ or is flawed because poor quality data sets were used to train the model. This can lead to **complexity and biases** which may be hidden or not evident to the companies using them for decision making.

In conclusion, using statistical data analytics for behavioral operations management in a controlled and ethical manner has many advantages for the organization, and if done correctly can have a substantial impact. Similarly, if done incorrectly can lead to catastrophic results.

Ans 3

	World Wide Orders		Exchange Rates			Calculations	
Customer	Quantity	Selling Price	Mean	Standard Deviation	Constant (k)	(standard div)^2	k^2
UK	10	57500	1.4	0.041	575000	0.001681	330625000000
France	2	75000	1.1	0.03	130000	0.0009	16900000000
Japan	8	8400000	0.009	0.00045	67200000	0.0000002025	4.51584E+15
canada	4	98500	0.824	0.0342	394000	0.00116964	155236000000
South Africa	2	4100000	0.0211	0.00083	8200000	0.0000006889	6724000000000
USA	1	100000	1	0	0	0	0

		Distribution		
Customer	Revenue from Customers (in $)		Standard Deviation	Variance
UK	805000		0.041	0.001681
France	143000		0.03	0.0009
Japan	604800		0.00045	0.0000002025
Canada	324656		0.0342	0.00116964
South Africa	173020		0.00083	0.0000006889
USA	100000		0	0

Mean Of Total Revenue	2150476
Variance of total revenue	1713340096
standard deviation of total revenue	41392.51256

Ans 3

$X \sim N(\mu, \sigma^2)$

This true because the rates are distributed normally.

(I) Mean total Revenue :

$$E(Q) = K_{UK} E(X_{UK}) + K_{France} E(X_{Fra}) + K_{Jap} E(X_{Jap}) + K_{canada} E(X_{can}) + K_{South\ Africa} E(X_{SA}) + K_{USA}$$

where K = constant = Quantity x Selling price.

$$E(Q) = 575000(1.4) + 130000(1.1) + 67200000(0.009) + 394000(0.824) + 8200000(0.0211) + 100000$$

$$\boxed{E(Q) = \$2,150,476}$$

Variance $= \sigma^2$

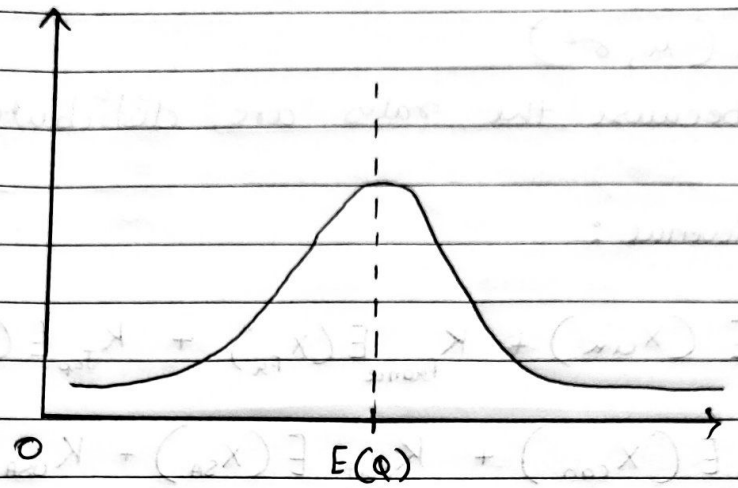
$$V(Q) = (K_{UK})^2 (Var)(X_{UK}) + (K_{France})^2 (Var)(X_{Fra}) + (K_{Jap})(Var)(X_{Jap}) + (K_{canada})(Var)(X_{can}) + (K_{SA})(Var)(X_{SA}) +$$

$$V(Q) = (575000)^2 (0.041)^2 + (130000)^2 (0.03)^2 + (67200000)^2 (0.00045)^2 + (394000)^2 (0.0342)^2 + (8200000)^2 (0.00083)^2$$

$$V(Q) = 1713340096$$

Standard deviation = $\sqrt{\text{Variance}}$

$$= \sqrt{1713340096} = \boxed{\$41392.51256}$$



$= 2150476\$$

(II) a) If $X = 2{,}300{,}000\ \$$

$M = E(Q) = 2{,}150{,}476\ \$$

$\sigma = \$\ 41392.5126$

$\therefore\ z = \dfrac{X - M}{\sigma} = \dfrac{2300000 - 2150476}{41392.5126}$

$z = 3.6123$

for $z = 3.6123$ (Z table)

$P(z > 2{,}300{,}000\$) = 0.0002$

$= \boxed{0.02\%}$

(b) if $X = 2{,}100{,}000\$$

$\therefore\ z = \dfrac{X - M}{\sigma} = \dfrac{2100000 - 2150476}{41392.5126}$

$z = -1.2194 \approx -1.22$ (using Z table)

$P(z < \$2\,100\,000) = 0.1113$

$= \boxed{11.13\ \%}$

(III) $X = \$2,170,000$

$$Z = \frac{X - \mu}{\sigma} = \frac{21700000 - 2150476}{41392.51256} = 0.4716$$

(using z table)

$$p(z < 2,170,000) = 0.3192$$

$$= \boxed{31.92\%}$$

$$100 - 31.92\% = 68.08\%$$

This means that there is a 68.08% chance of getting a worse ROR (return of revenue) so pharmaco should take this offer.

(III) $X = \$2,170,000$

$$Z = \frac{X - \mu}{\sigma} = \frac{21700000 - 2150476}{41392.51256} = 0.4716$$

(using z table)

$$p(z < 2,170,000) = 0.3192$$

$$= \boxed{31.92\%}$$

$$100 - 31.92\% = 68.08\%$$

This means that there is a 68.08% chance of getting a worse ROR (return of revenue) so pharmaco should take this offer.