

# Factors Affecting Quality of a CO-OP placement in Engineering TMU

**IND605 - Section 1 - Group 5**

**Experimental Design & Quality Assurance**

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# 01

## Topic Overview

1. Key focus of the project is analyzing the key factors that affect the quality of co-op placements for engineering students, specifically in **INDUSTRIAL**, **MECHANICAL** and **COMPUTER** Engineering.
2. Co-op Program bridges the gap between theoretical education, and the practical real world jobs. the quality of co-op can affect the students career significantly, either launching their careers towards success, or discouraging them and their initial ambitions
3. Employing (DOE) and Control Chart analysis to identify which factor, them being the students CGPA, and engineering discipline is most impactful.

# Project Statement

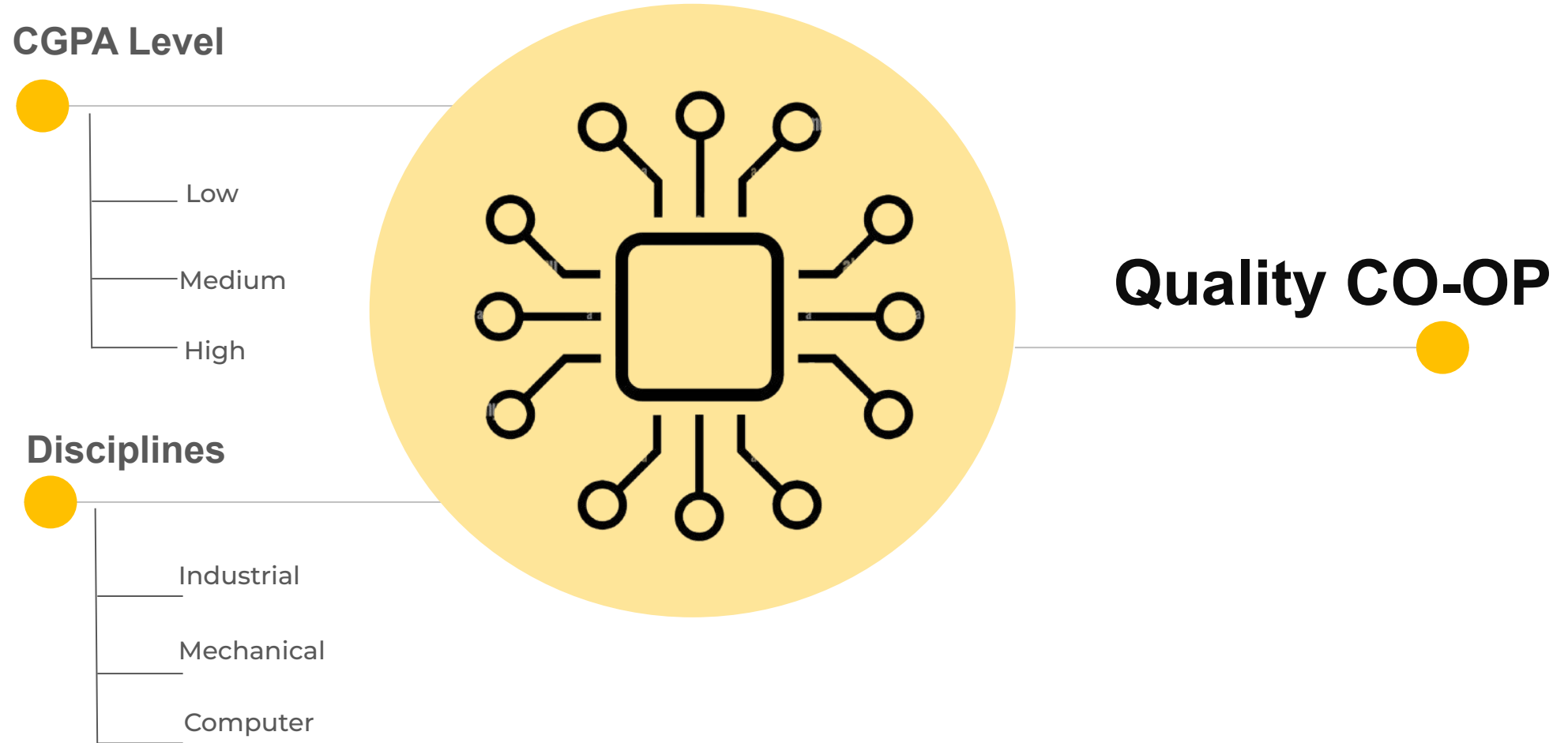
To provide actionable insights for students and TMU's co-op office in enhancing co-op experiences and outcomes.



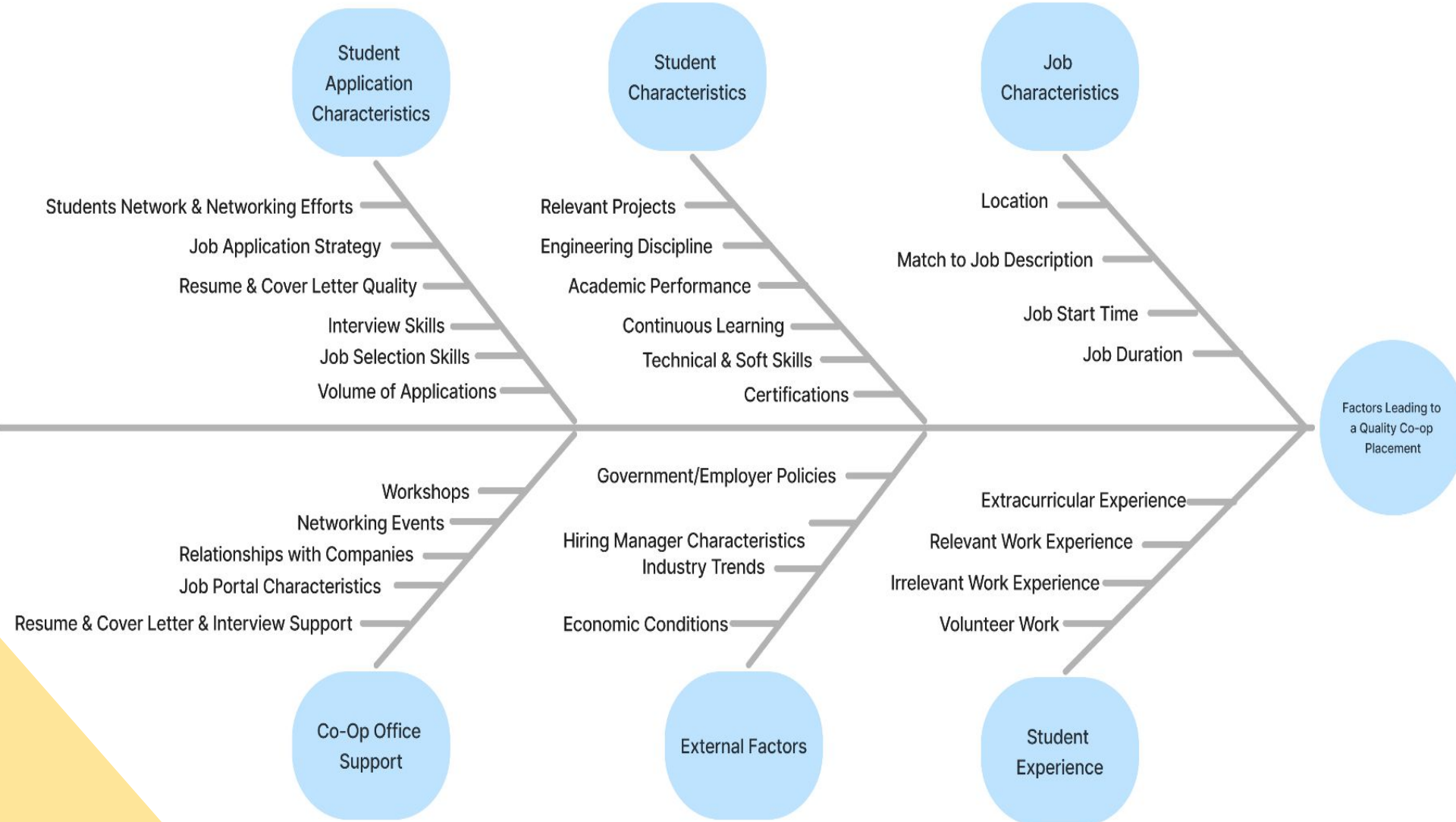
# 02 Quality Characteristic



# Factors



# 03 Cause and Effect Diagram



- project was initiated based on the creation of this cause and effect diagram.
- the diagram was made in order to define the factors in order to achieve a high quality co-op placement.



## 04

# CONTROL CHART ANALYSIS



Control Chart Used to:

- monitor trends
- identify Variation



# The Use Of **Control Chart Analysis** To Monitor Trends, And Identify Variation

9 initial configurations of control charts were created

:

Factor 1: Engineering discipline 3 levels, **Industrial**, **Mechanical** and **Computer**

Factor 2: CGPA is also split into 3 levels being **Low**, **Medium** and **High**

- It is important to note that the configurations created will be applied twice, once for each quality characteristic. which would mean 18 control charts will be initially analyzed.

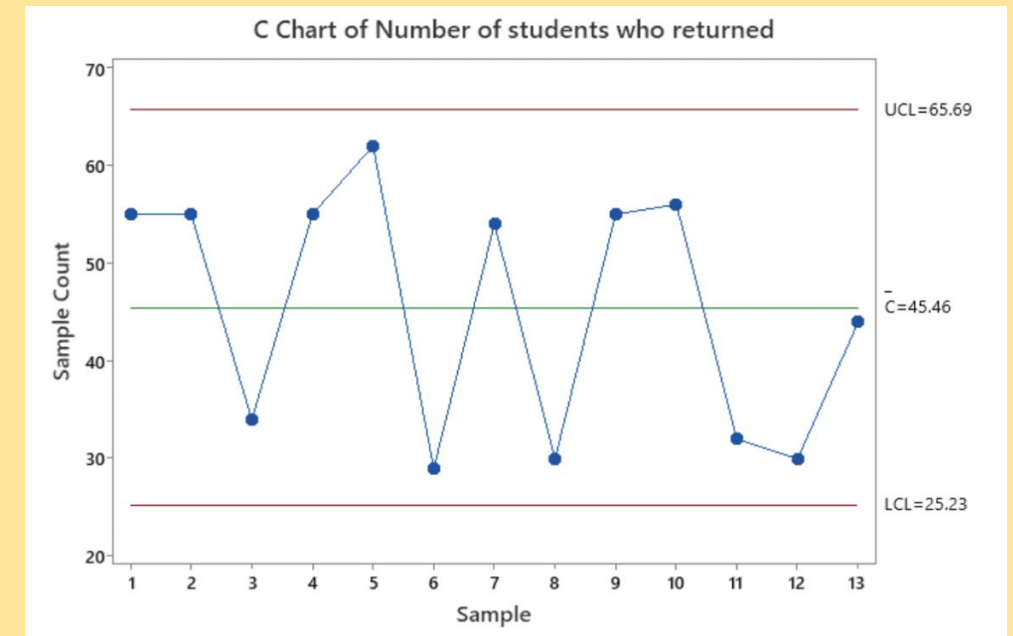
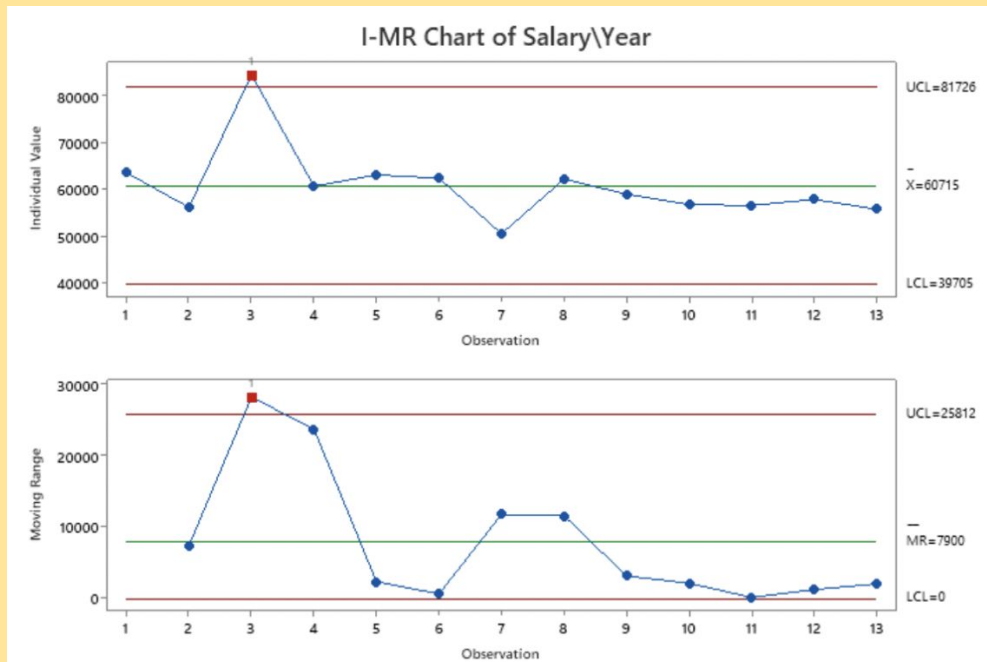
Configuration	Engineering Discipline	CGPA Level
Config 1	Indy	Low
Config 2	Indy	Med
Config 3	Indy	High
Config 4	Mech	Low
Config 5	Mech	Med
Config 6	Mech	High
Config 7	Comp	Low
Config 8	Comp	Med
Config 9	Comp	High

# Control Charts Analysis, The out of control configurations

- I-MR control charts was conducted, for the Salary/Year of each student, as it is a continuous data with a sample size of 1.
- A C-chart was used in order to analyze the number of students that returned after graduation, as the sample size remained constant.

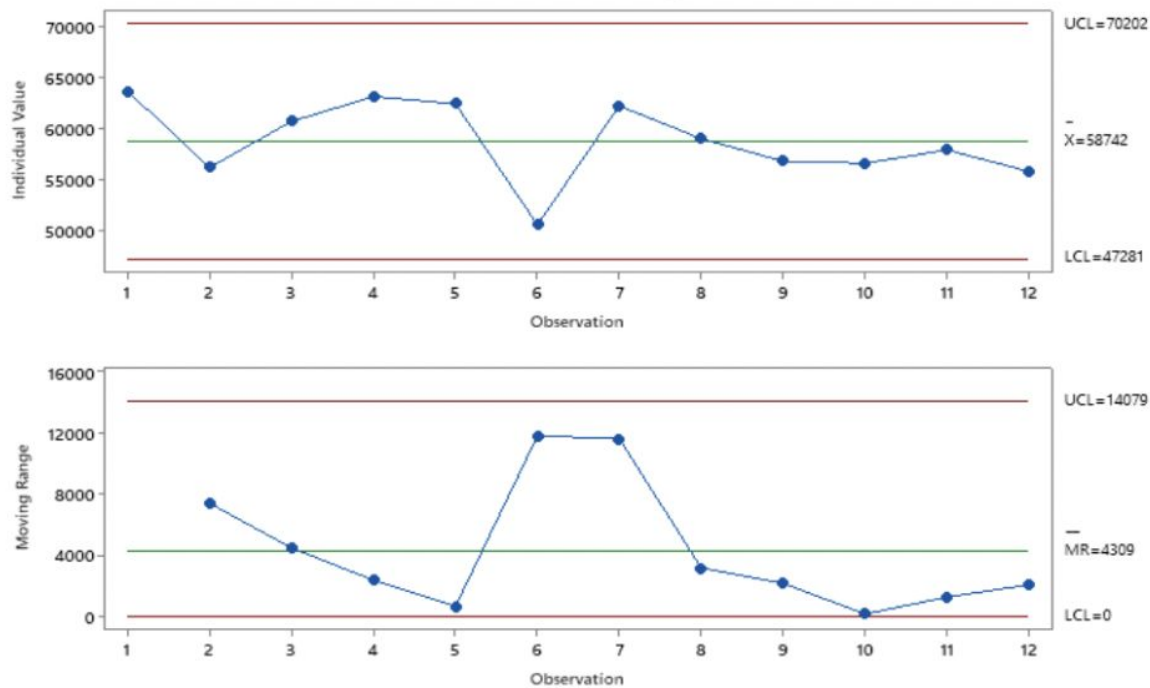
*Out of the 18 control Charts were the following configurations (2,6,8) were out of control.*

## Initial Charts for Configuration 2

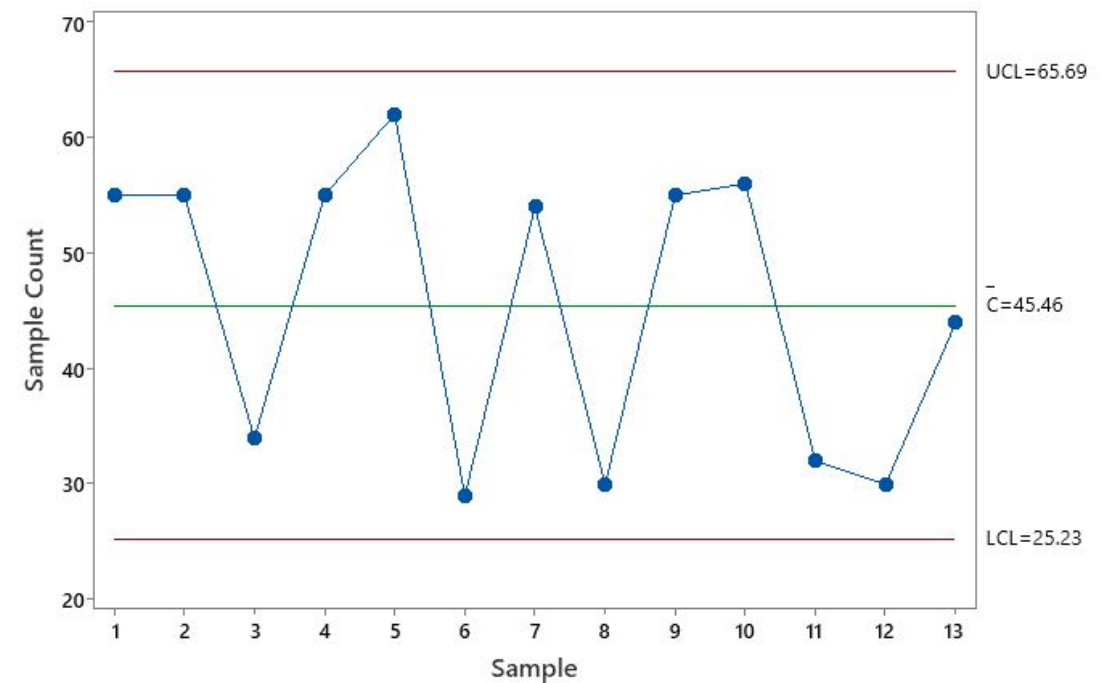


# Revised Control Charts Configuration 2

I-MR Chart of Salary\Year

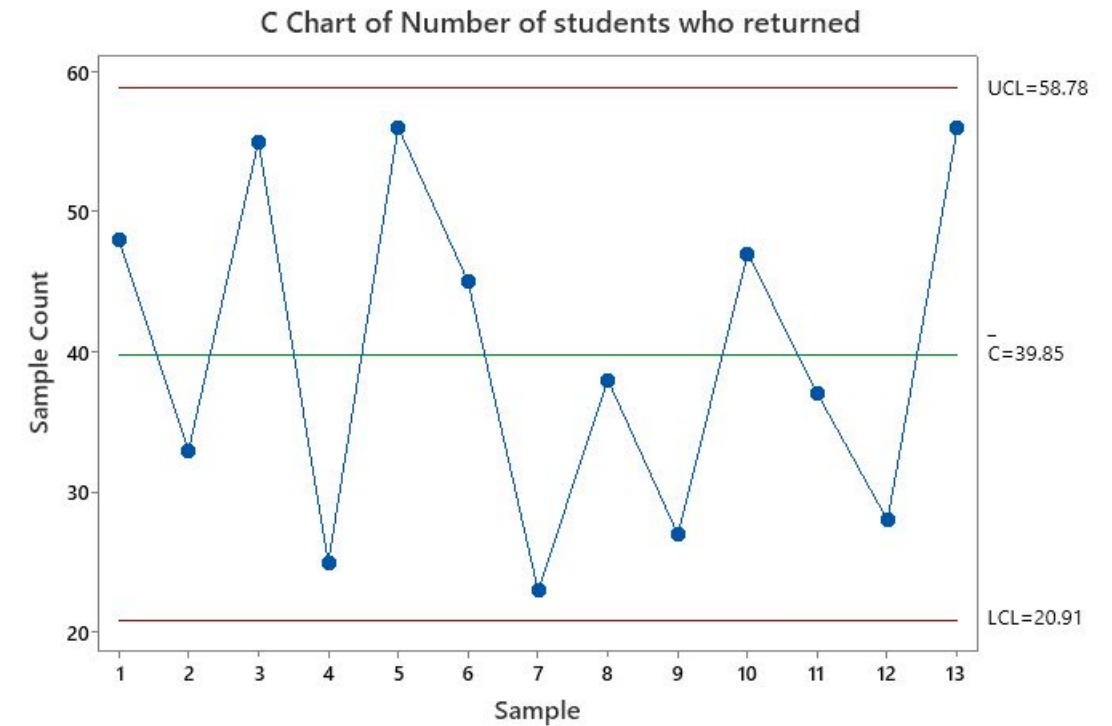


C Chart of Number of students who returned



# Initial I-MR Control Charts For Configuration 6

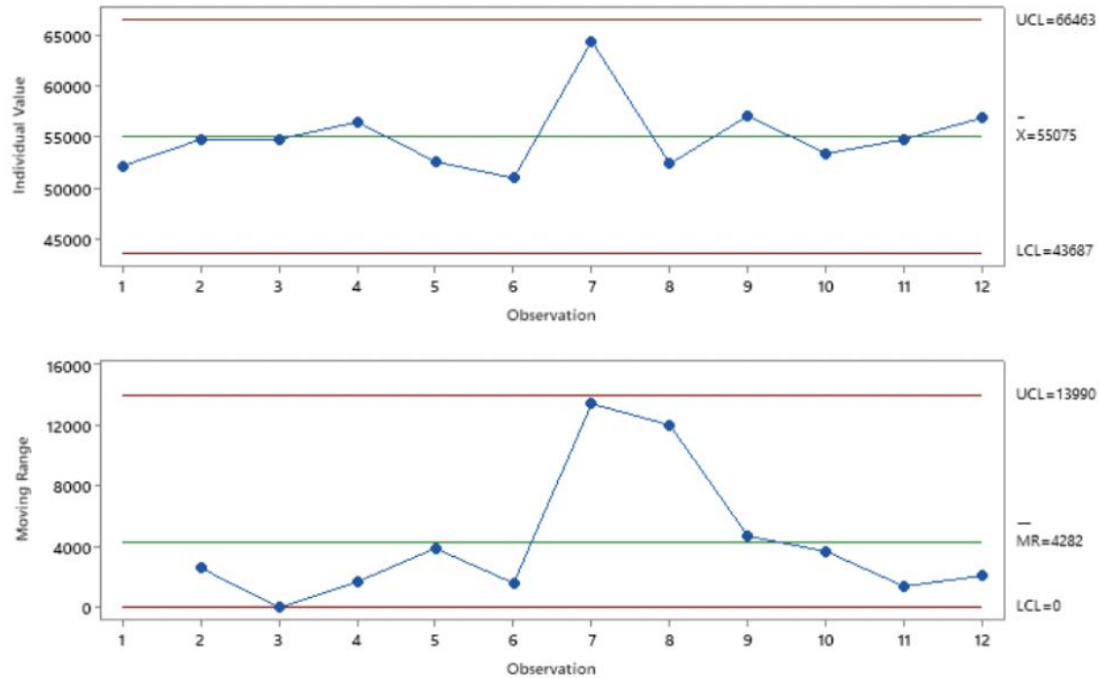
12



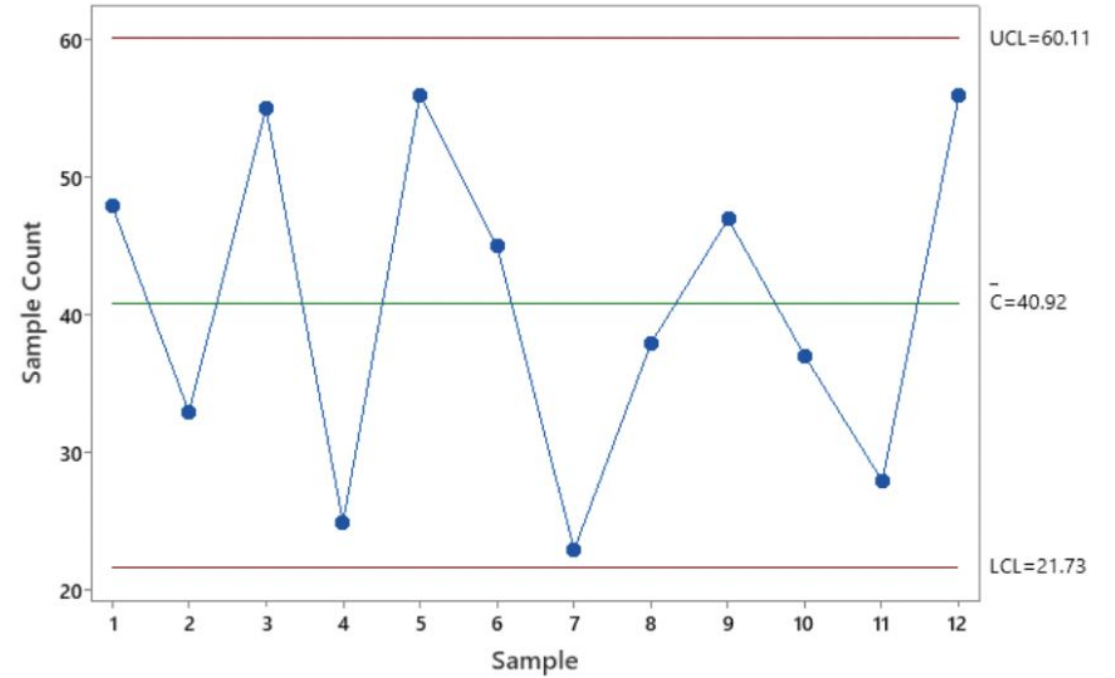
# Revised I-MR **Control Charts** For Configuration 6

13

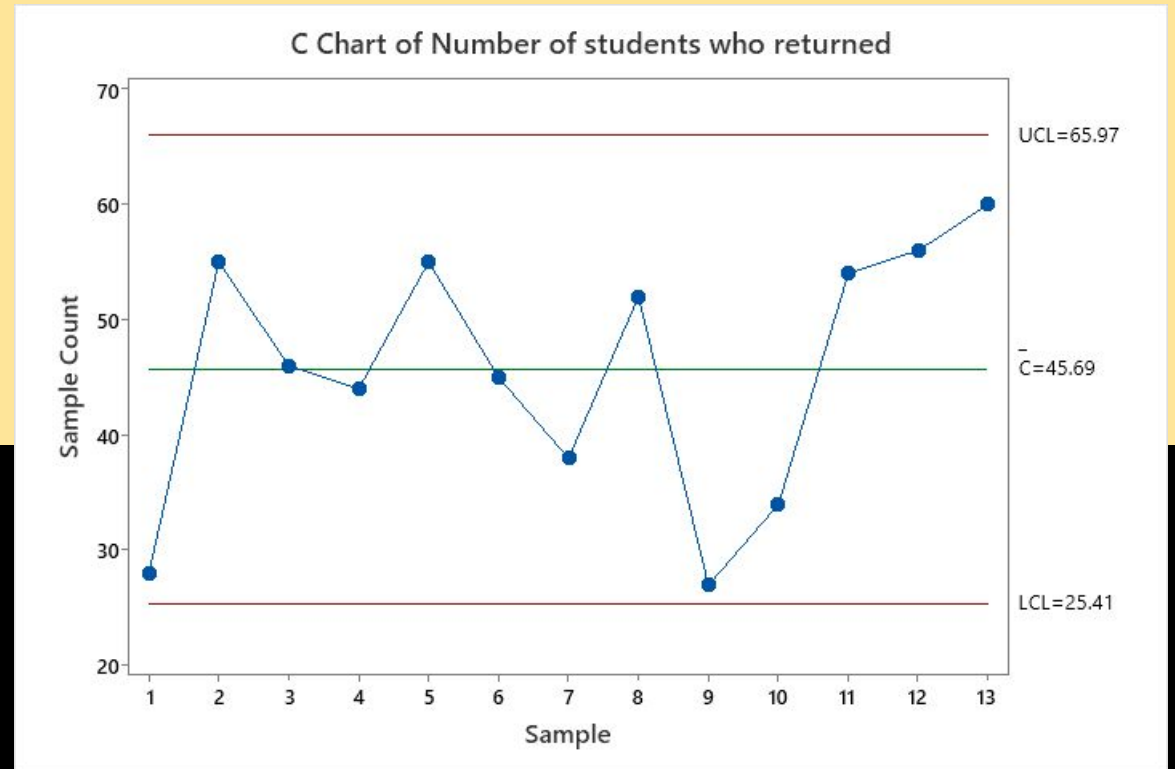
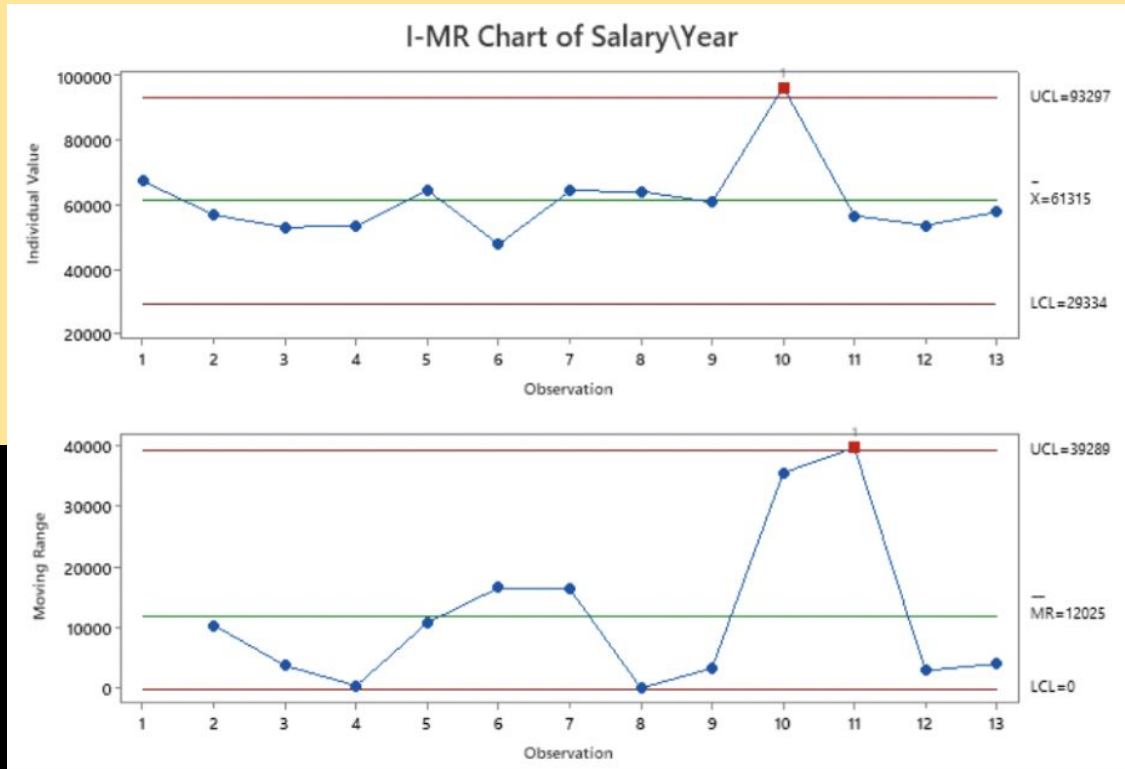
I-MR Chart of Salary\Year



C Chart of Number of students who returned

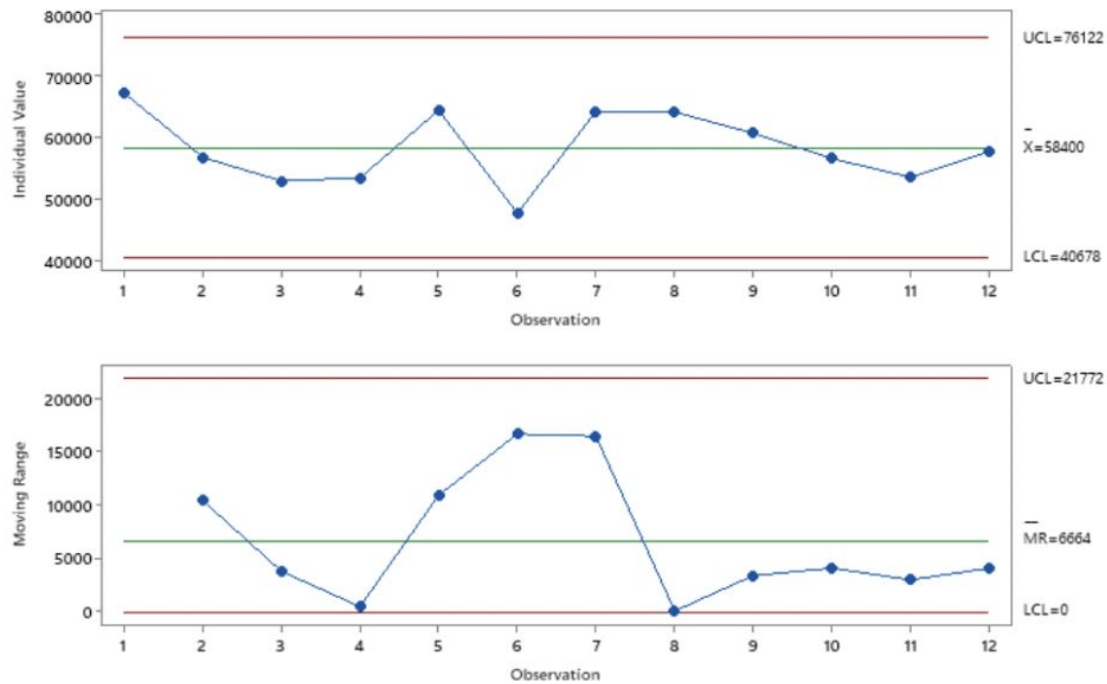


# Initial I-MR Control Charts For Configuration 8

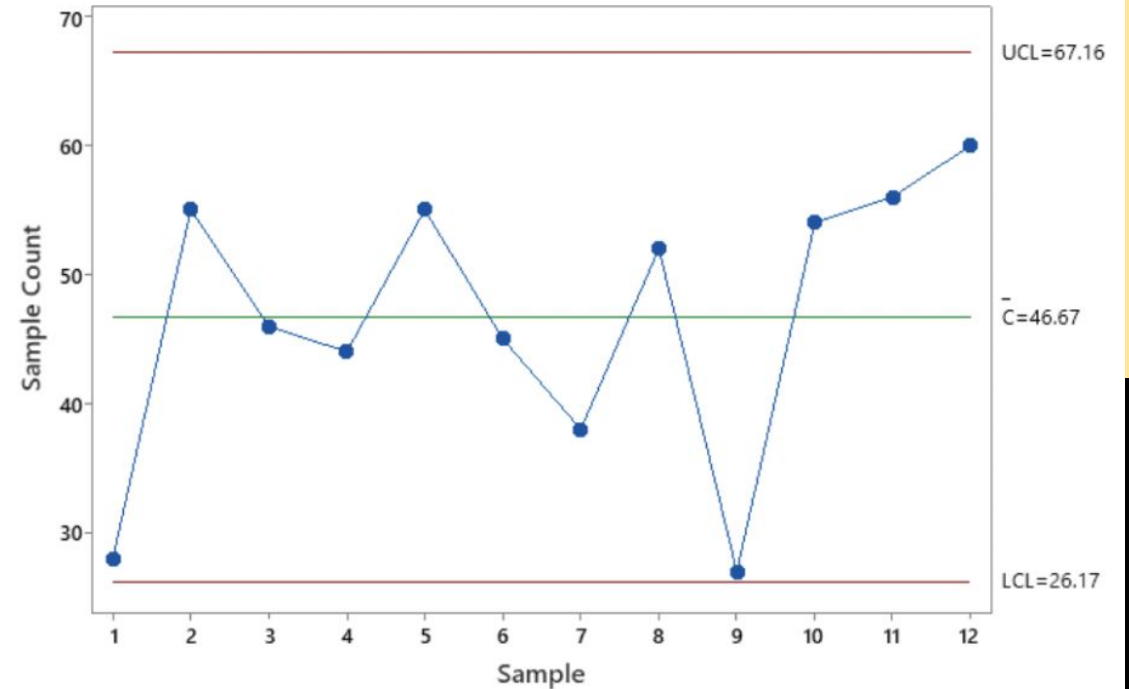


# Revised I-MR **Control Charts** For Configuration 8

I-MR Chart of Salary\Year



C Chart of Number of students who returned





## 05

# Normality Test

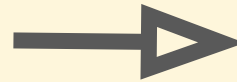
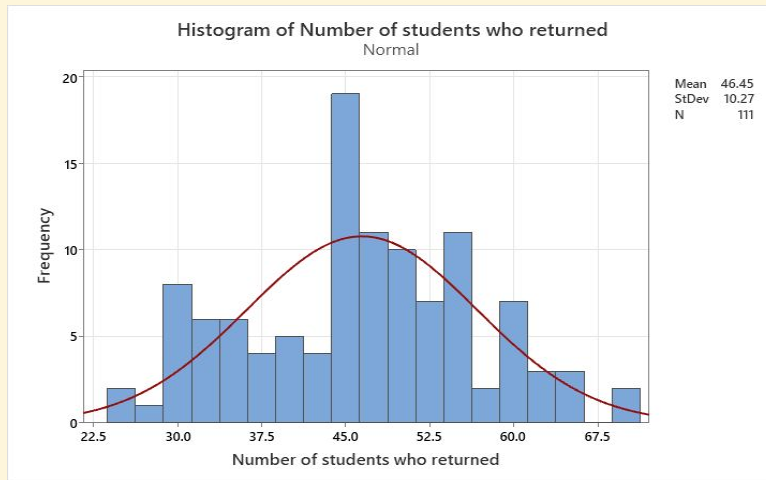
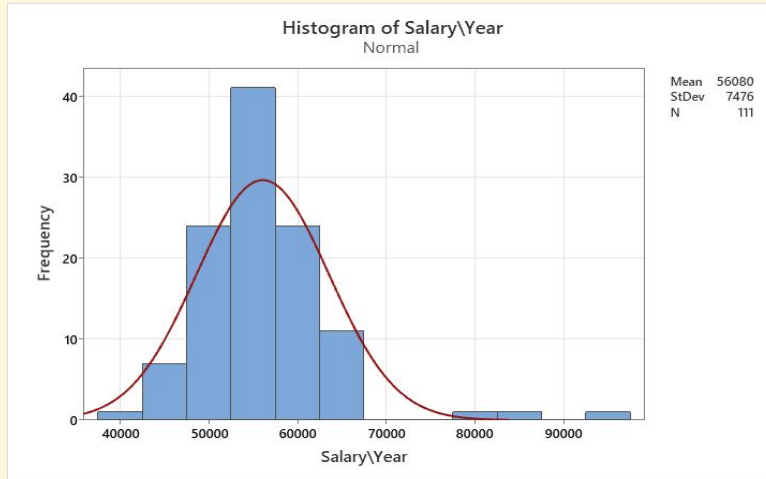


- Ensuring the data can be effectively employed for the Statistical techniques

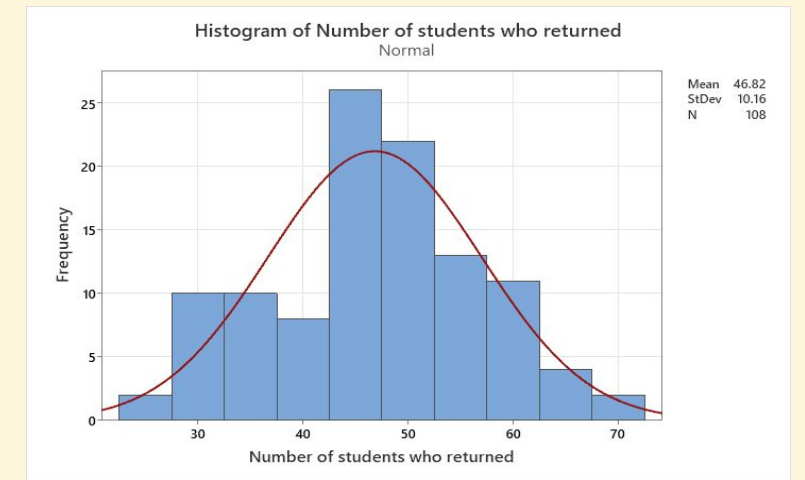
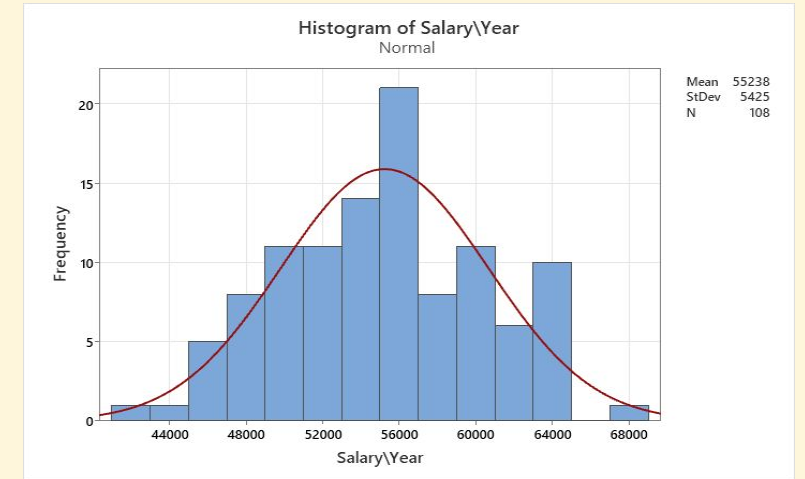


# Histogram

Initial

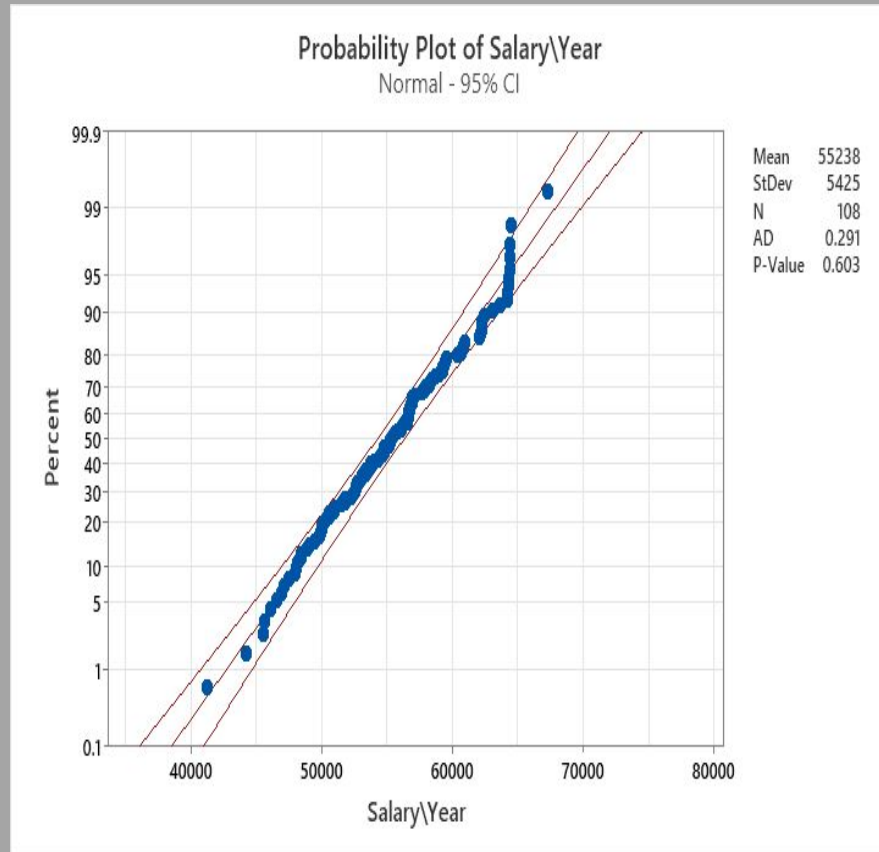


Controlled

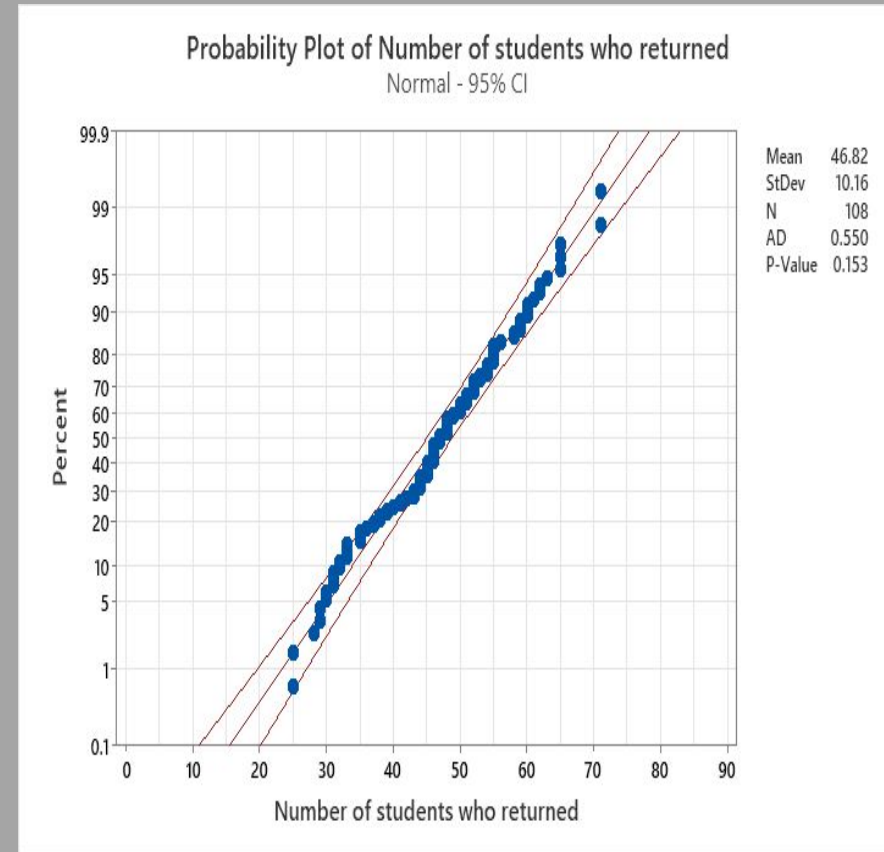


# Probability Plot

18



**QC #1 Salary/Year**



**QC #2 Number of  
students who returned**

# 06

## Factorial Design



# The Goals Of **Factorial Design**

01

Understanding and  
assessing the individual  
factors impact

02

Explore how different  
factors work Together

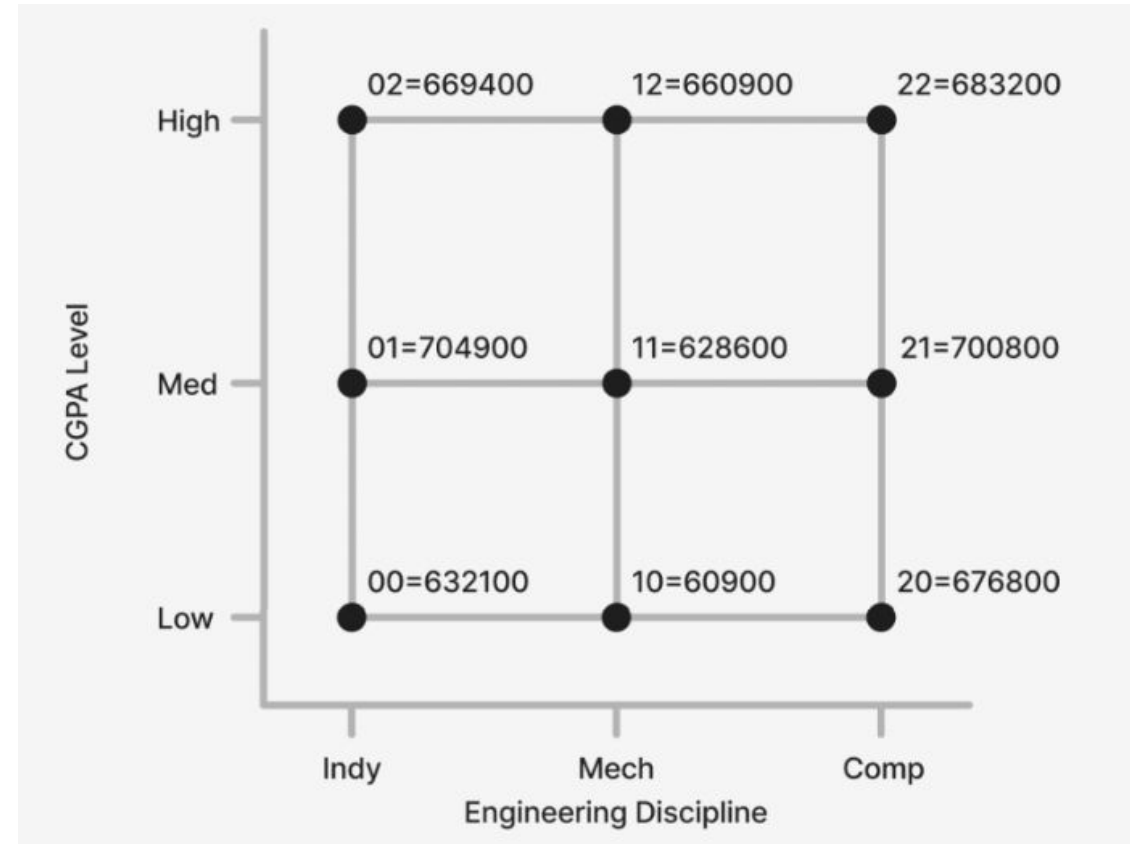
03

Identify the best  
combinations to improve  
overall co-op quality

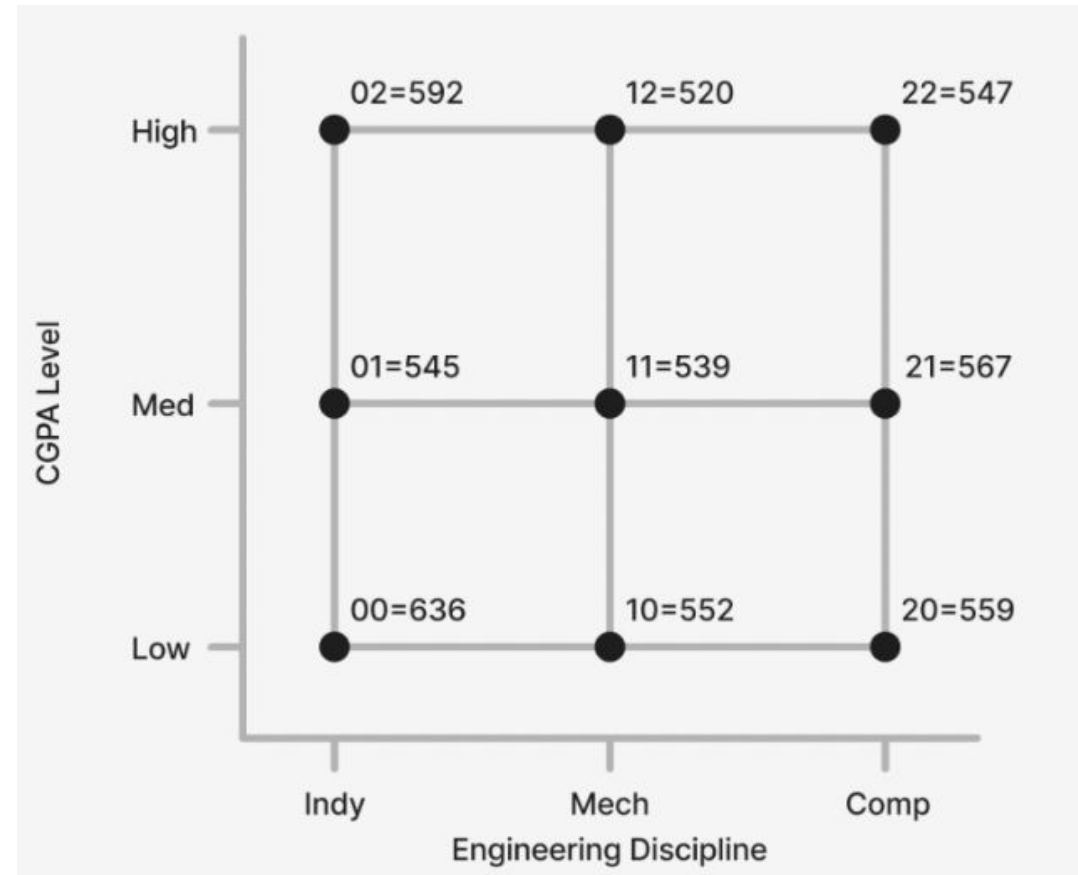
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Obtain valuable insights in order  
to guide students, and co-op  
office in enhancing the outcome  
of placements

# The Factorial Design **analysis** QC #1



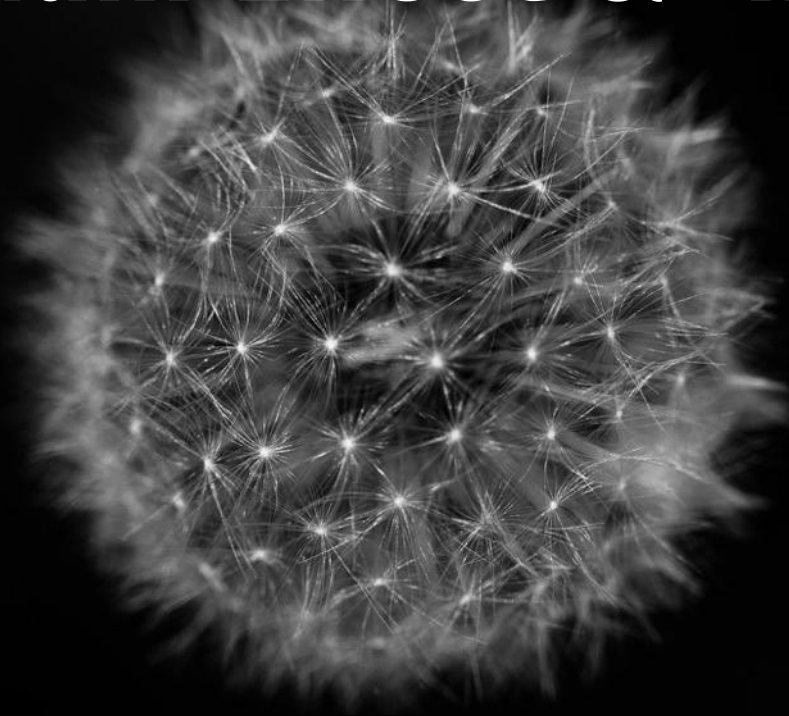
# The Factorial Design **analysis** QC #2





## 07

# Main Effect & Interaction Plot



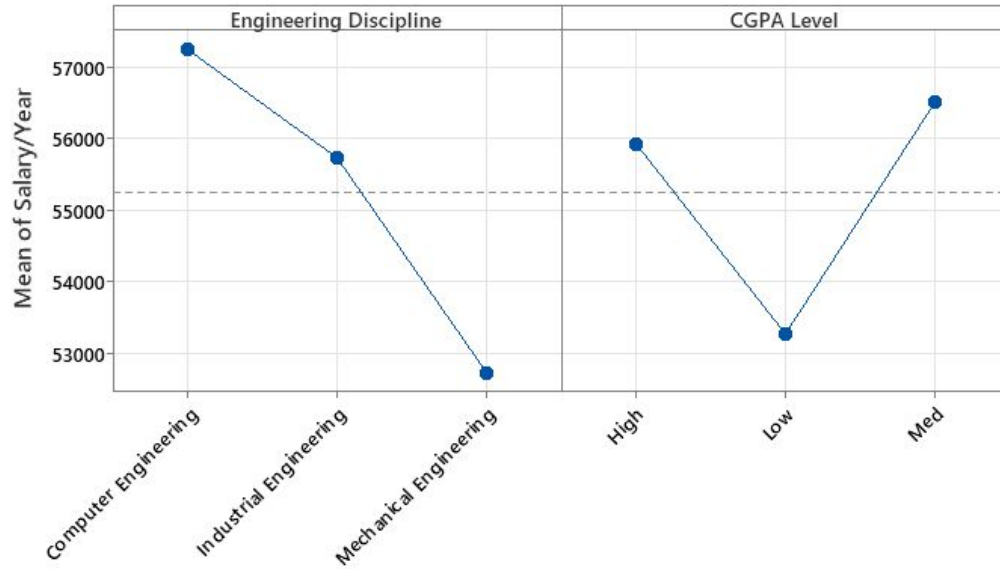
To understand the individual effects of each level on the response



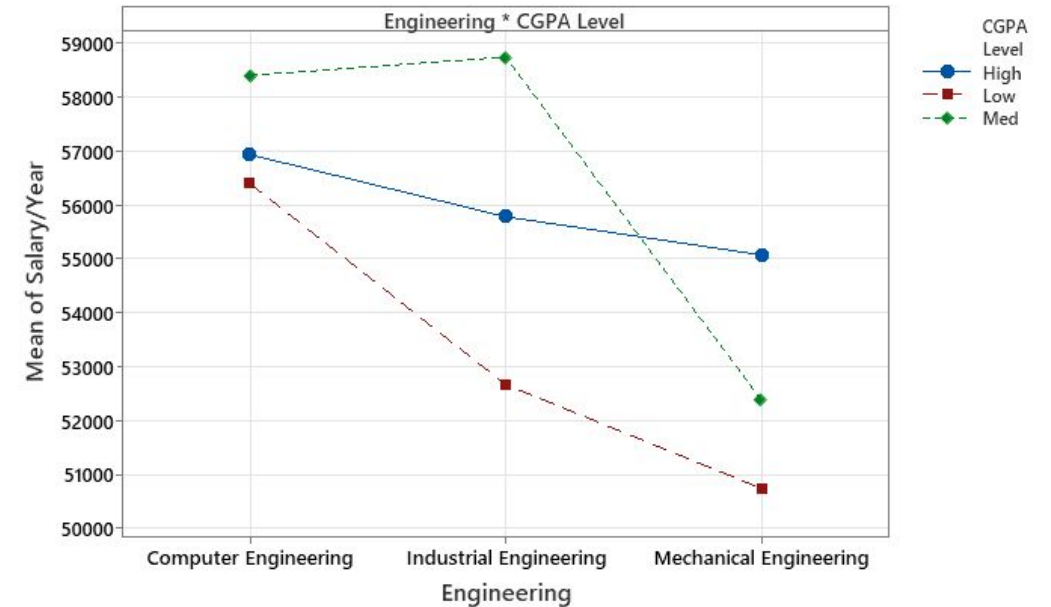
# Interaction & Main Effect Plots

## Salary/Year Quality Characteristic #1

Main Effects Plot for Salary/Year  
Fitted Means



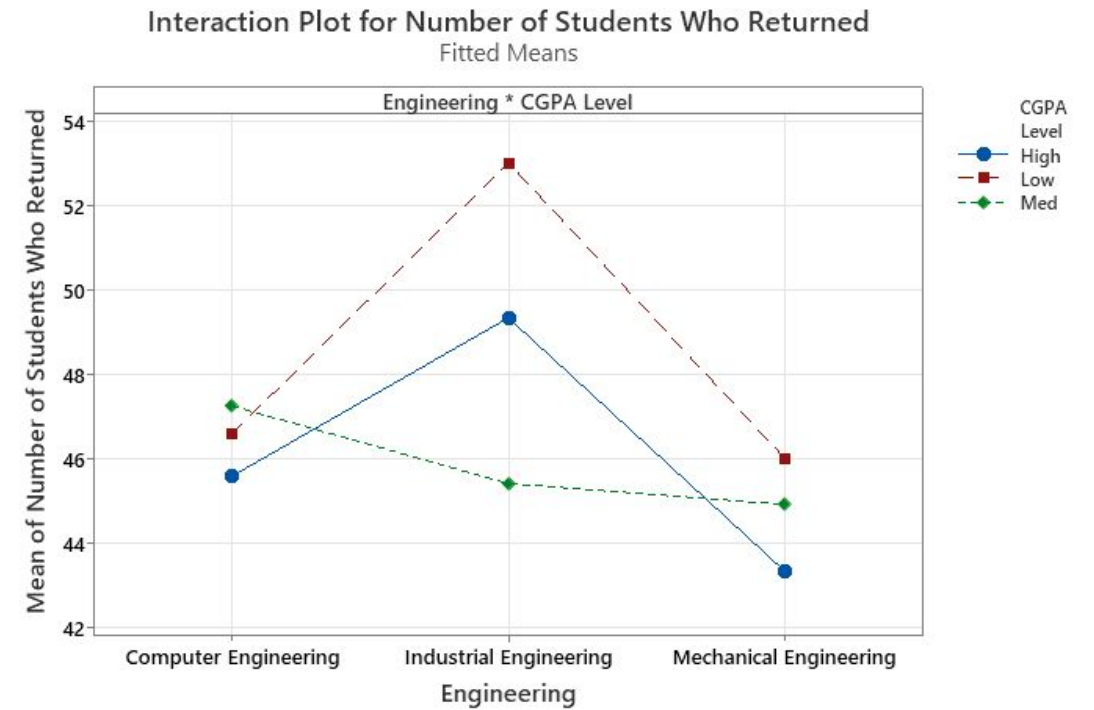
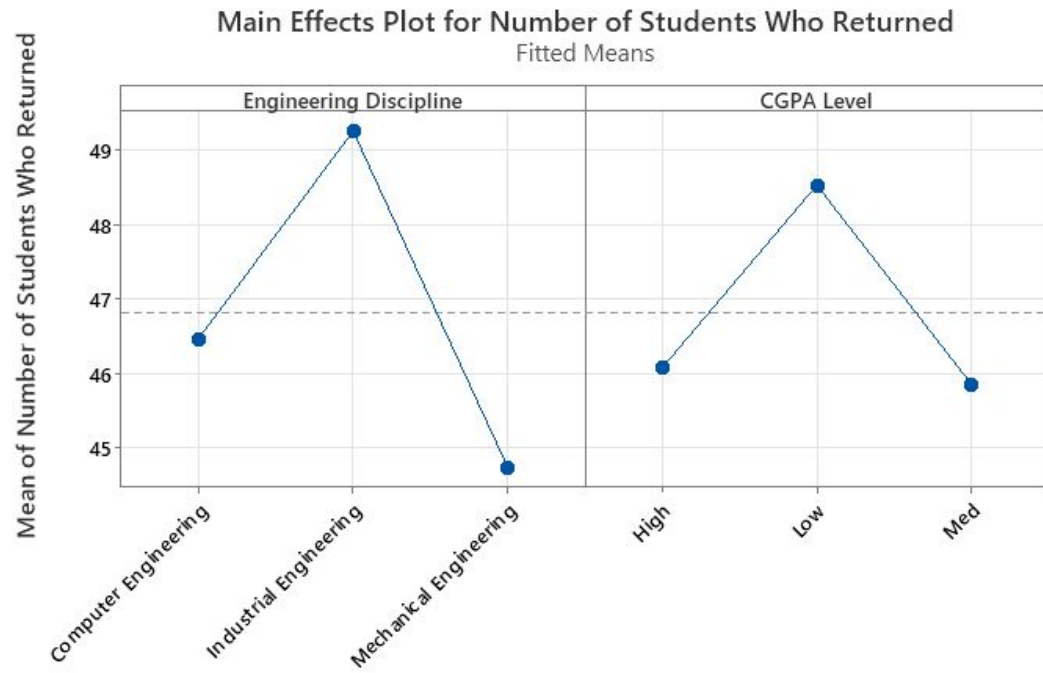
Interaction Plot for Salary/Year  
Fitted Means





# Interaction & Main Effect Plots

## ● Number of Students Who Returned Quality Characteristic #2

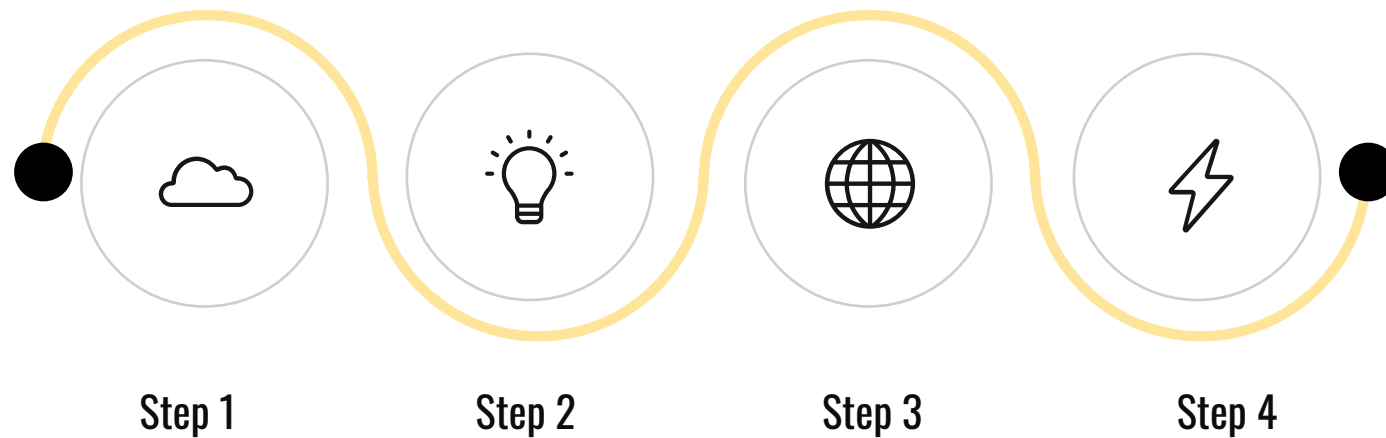


08

# Design Of Experiment & ANOVA



# Procedure For The **ANOVA TEST**



- **Step 1**  
Identify the levels, and factors
- **Step 2**  
Conduct calculations on minitab for the dataset
- **Step 3**  
Perform ANOVA Test
- **Step 4**  
Interpret results, draw up conclusions



# The ANOVA Test Results Determined The **Statistical Significance** of factor or combination

## Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	740190185	92523773	3.80	0.001
Linear	4	593185370	148296343	6.09	0.000
Engineering Discipline	2	379102407	189551204	7.79	0.001
CGPA Level	2	214082963	107041481	4.40	0.015
2-Way Interactions	4	147004815	36751204	1.51	0.205
Engineering Discipline*CGPA Level	4	147004815	36751204	1.51	0.205
Error	99	2408764167	24330951		
Total	107	3148954352			

Anova Table for Salary/Yr QC#1

## Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	8	776.4	97.05	0.94	0.491
Linear	4	528.8	132.20	1.27	0.285
Engineering Discipline	2	371.2	185.59	1.79	0.173
CGPA Level	2	157.6	78.81	0.76	0.471
2-Way Interactions	4	247.6	61.90	0.60	0.666
Engineering Discipline*CGPA Level	4	247.6	61.90	0.60	0.666
Error	99	10271.2	103.75		
Total	107	11047.7			

Anova Table for Student Returning QC#2


$$F_{0.05,2,99} = 3.09 \quad F_{0.05,4,99} = 2.46$$

F-Value,  
Independent  
Factors

F-Value, For  
Interaction Of  
Factors

## Let's talk about **facts**

Before analyzing the ANOVA tables the critical F-value must be calculated, this will be used to determine if the factors or their combination are statistically significant. Using Minitab the calculated critical F-values are as follow.



# ANOVA results Quality **Characteristic #1**

## CGPA Level **Factor Result**

**F-value:** 4.40 (greater than critical value 3.09).

**P-value:**  $< 0.05$ .

**Result:** Significant effect on group mean, but smaller than the impact of discipline.

## Engineering Discipline **Factor Result**

**F-value:** 7.79 (greater than critical value 3.09).

**P-value:**  $< 0.05$ .

**Result:** Significant impact on the group mean, with the largest effect among factors.

## Interaction Of **Factors**

**F-value:** 1.51 (less than critical value 2.46).

**P-value:** 0.205 (greater than **0.05**).

**Result:** Interaction of factors does not significantly impact the group means

# ANOVA results Quality **Characteristic #2**

## CGPA Level **Factor Result**

## Engineering Discipline **Factor Result**

## Interaction Of **Factors**

**F-value:** 0.76 (Less than critical value 3.09).

**P-value:**  $> 0.05$ .

**Result:** No Significant effect on group response mean.

**F-value:** 1.79 (greater than critical value 3.09).

**P-value:**  $< 0.05$ .

**Result:** No Significant effect on group response mean.

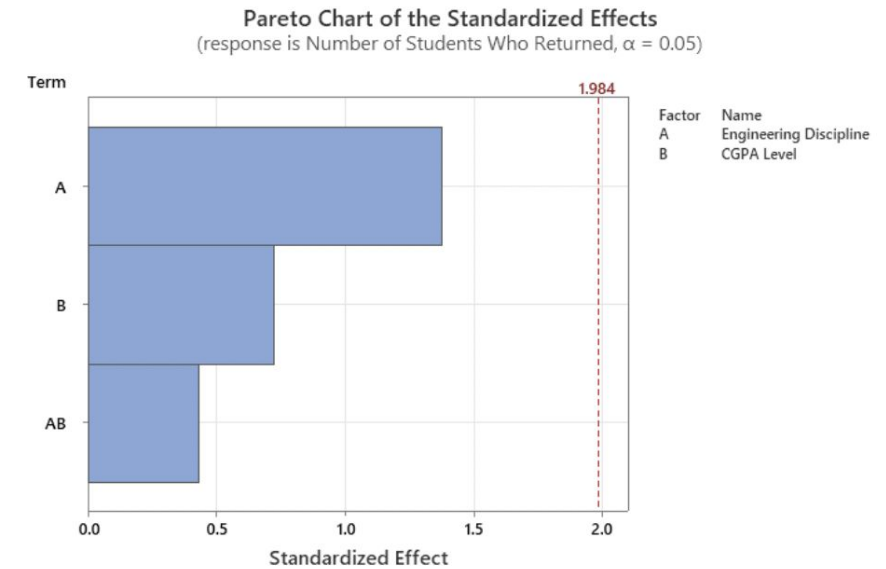
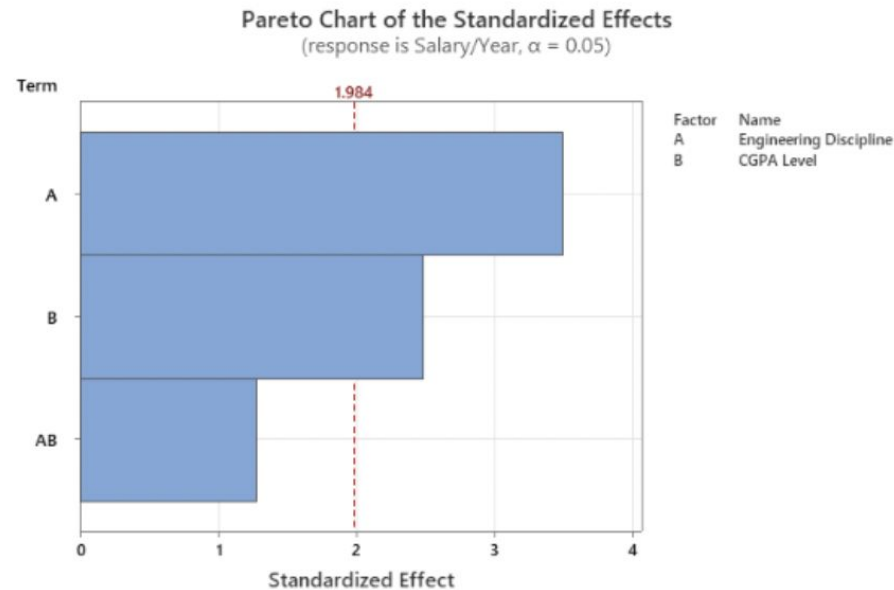
**F-value:** 0.60 (less than critical value 2.46).

**P-value:** 0.205 (greater than **0.05**).

**Result:** Interaction of factors does not significantly impact the group mean

# ANOVA Pareto Charts

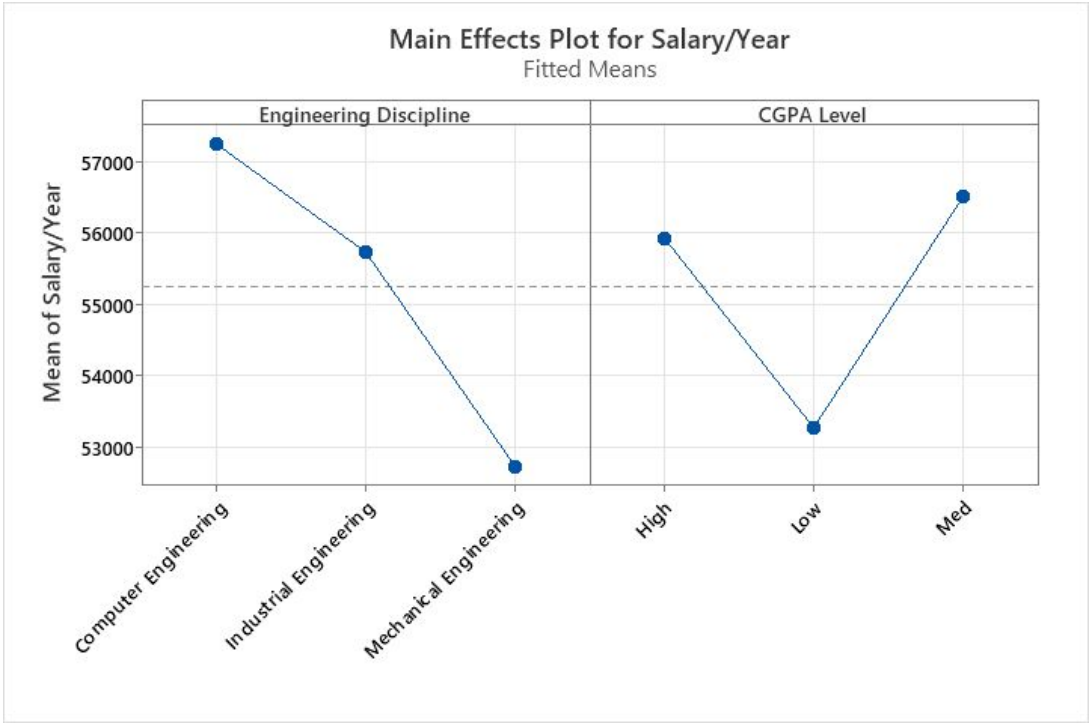
32



Pareto for Standardized  
Effects Salary/Yr

Pareto for Standardized Number of  
students who returned

Factor	Level	Mean Effect
Engineering Discipline	Industrial Engineering	495.37
	Mechanical Engineering	-2501.85
	Computer Engineering	2006.48
CGPA Level	Low	-1962.96
	Med	1270.37
	High	692.59



# Mean Effect Data Summary

# 09 Conclusion

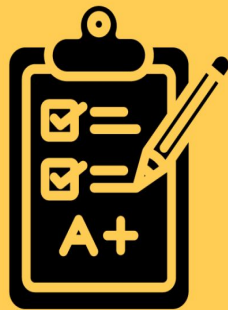


Computer and Industrial Engineering lead to higher salaries, while Mechanical Engineering offers lower salaries.



CGPA and field of study do not influence the likelihood of returning to the same company.

Inference that success in co-ops depends more on personal and professional growth outside academics.



Students with medium GPA (2.56–3.44) earned the highest salaries

# 10 References

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Montgomery, D. C. (2020). Introduction to statistical quality control. John Wiley & Sons, Inc.

Graham, H. (2005). *University of Sussex*. F-Ratio Table. Retrieved from:

<https://users.sussex.ac.uk/~grahamh/RM1web/F-ratio%20table%202005.pdf>

National Institute of Standards and Technology. (n.d.). *US Department of Commerce*. Three-level full factorial designs. <https://www.itl.nist.gov/div898/handbook/pri/section3/pri339.htm>

A nighttime photograph of a city skyline, featuring numerous illuminated skyscrapers and buildings. The scene is dark, with the city lights providing the primary illumination. A large, solid yellow circle is positioned at the top center of the frame. Overlaid on the image is the text "Thanks For Listening!" in a large, bold, sans-serif font. The word "Thanks" is yellow, and "For Listening!" is white.

**Thanks**  
**For Listening!**