TOPIC: DESIGN OF EXPERIMENT

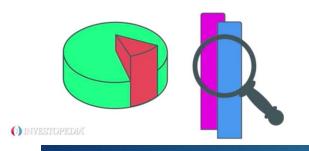
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AGENDA: To show use of excel in Design of Experiment.

- ► Index:
- ▶ 1)Introduction of Design Of Experiment
- 2) Completely Randomized Design using excel
- > 3) Randomized Block Design(Without replication) using excel
- ▶ 4) Randomized Block Design(With replication) using excel
- ▶ 5) 2^2 Factorial Experiment

STATISTICS



Design of Experiment

WHAT IS DESIGN OF EXPERIMENTS?

DESIGN OF EXPERIMENTS (DOE) IS A SYSTEMATIC, EFFICIENT METHOD THAT ENABLES SCIENTISTS AND ENGINEERS TO STUDY THE RELATIONSHIP BETWEEN MULTIPLE INPUT VARIABLES (AKA FACTORS) AND KEY OUTPUT VARIABLES (AKA RESPONSES). IT IS A STRUCTURED APPROACH FOR COLLECTING DATA AND MAKING DISCOVERIES.

• When to use DOE?

- 1)To determine whether a factor, or a collection of factors, has an effect on the response.
- 2)To determine whether factors interact in their effect on the response.
- 3)To model the behavior of the response as a function of the factors.
- 4)To optimize the response.

Why use DOE?

- DOE is useful:
- In driving knowledge of cause and effect between factors.
- ▶ To experiment with all factors at the same time.
- To run trials that span the potential experimental region for our factors.
- In enabling us to understand the combined effect of the factors.
- To illustrate the importance of DOE, let's look at what will happen if DOE does NOT exist.
- Experiments are likely to be carried out via trial and error or one-factorat-a-time (OFAT) method.

CRD(Completely Randomised Design):

- Description of the Design
- Simplest design to use.
- Design can be used when experimental units are essentially homogeneous.
- Because of the homogeneity requirement, it may be difficult to use this design for field experiments.
- The CRD is best suited for experiments with a small number of treatments.

Advantages of a CRD

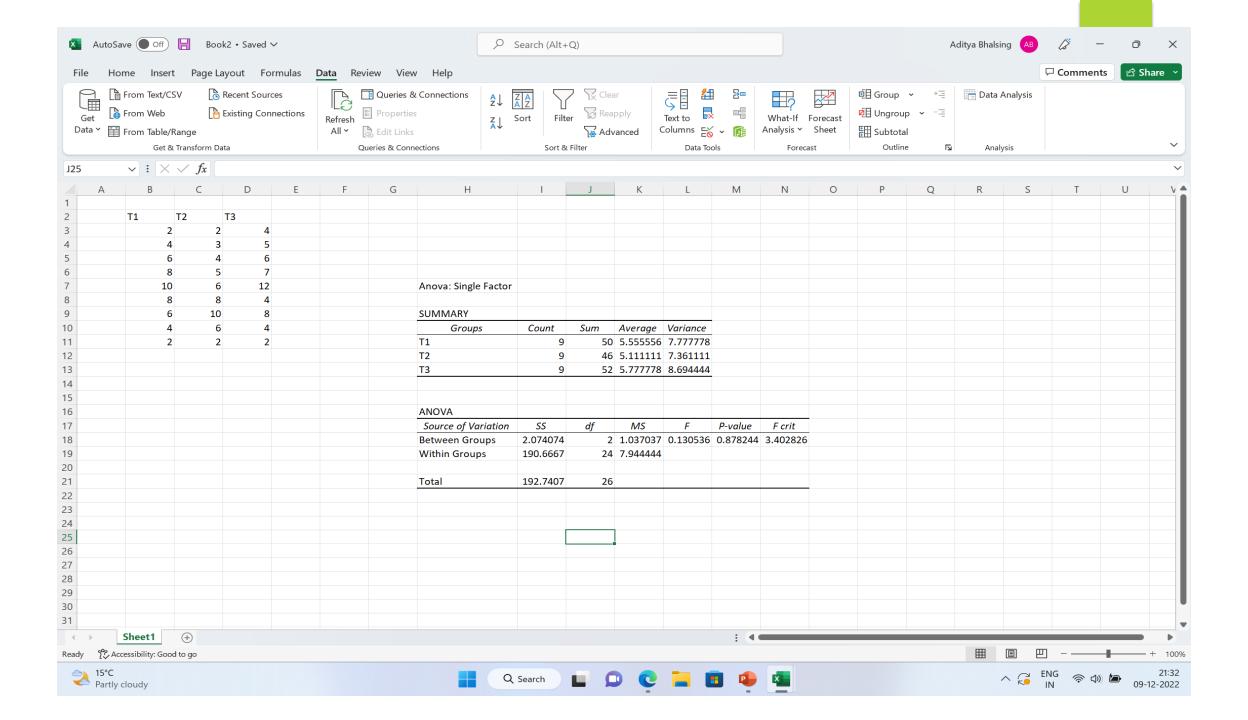
- Very flexible design (i.e. number of treatments and replicates is only limited by the available number of experimental units).
- Statistical analysis is simple compared to other designs.
- Loss of information due to missing data is small compared to other designs due to the larger number of degrees of freedom for the error source of variation.

<u>Disadvantages</u>

- If experimental units are not homogeneous and you fail to minimize this variation using blocking, there may be a loss of precision.
- Usually the least efficient design unless experimental units are homogeneous.
- Not suited for a large number of treatments

Randomization Procedure

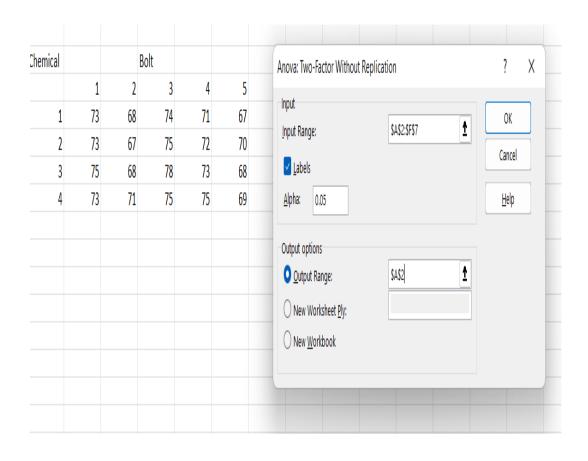
- Treatments are assigned to experimental units completely at random.
- Every experimental unit has the same probability of receiving any treatment.
- Randomization is performed using a random number table, computer, program



Randomized block designs (Without Repitation):

- ▶ 1)Randomized block design are used to study the interaction between blocks and treatments.
- ▶ 2) Each treatment is replicated at least two times in each block.
- 3)In Randomized block design ,Total variation is devided into three components,viz.,Block,Treatment and Error.

Randomized Block Design (Without Repitation) in Excel:



OUTPUT:

Chemical			Bolt			Anova: Two	o-Factor Wi	thout Rep	lication			
		1 2	3	4	5							
1	7	68	74	71	67	SUMMARY	Count	Sum	Average	Variance		
2	7	67	75	72	70		5	15	3	2.5		
3	7	68	78	73	68	1	5	353	70.6	9.3		
4	7	3 71	. 75	75	69	2	5	357	71.4	9.3		
						3	5	362	72.4	19.3		
						4	5	363	72.6	6.8		
							5	295	59	1052		
							5	276	55.2	886.7		
						Bolt	5	305	61	1053.5		
							5	295	59	947.5		
							5	279	55.8	807.7		
						ANOVA						
						Source of Varia	SS	df	MS	F	P-value	F crit
						Rows	18919.2	4	4729.8	1074.955	3.2E-19	3.00691
						Columns	118.4	4	29.6	6.727273	0.002249	3.00691
						Error	70.4	16	4.4			
						Total	19108	24				

Randomized Block Design (WithRepitation) in Excel:

A	В	C	D	E	F	G	Н	1	J	K	L	M	N	0	P	Q	R	S	T	U
Counseling	Drug Use	Violence	Depression																	
Individual	57	45	30																	
Individual	64	43	27																	
Individual	55	42	37																	
Individual	69	39	28				Anova: Tw	o-Factor W	ith Replica	tion										
Individual	41	36	39																	
Individual	72	42	41				SUMMARY	Drug Use	Violence	Depression	Total									
Individual	66	41	44				Individual													
Individual	55	49	33				Count	10	10	10	30									
Individual	49	54	29				Sum	595	446	353	1394									
Individual	67	55	45				Average	59.5	44.6	35.3	46.46667									
Group	71	45	55				Variance	96.05556	38.93333	46.01111	158.9471									
Group	66	54	41																	
Group	69	51	33				Group													
Group	78	49	32				Count	10	10	10	30									
Group	59	57	27				Sum	714	523	406	1643									
Group	72	55	22				Average	71.4	52.3	40.6	54.76667									
Group	73	60	49				Variance	41.15556	21.12222	144.7111	230.9437									
Group	77	54	44																	
Group	81	51	44				Total													
Group	68	47	59				Count	20	20	20										
							Sum	1309	969	759										
							Average	65.45	48.45	37.95										
							Variance	102.2605	44.05	97.73421										
							ANOVA													
						Sou	rce of Vario	SS	df	MS	F	P-value	Fcrit							
							Sample	1033.35	1	1033.35	15.9801	0.000196	4.019541	reject nul	means sign	nificant diff	erence b/v	counselin	group	
							Columns	7703.333			59.56356									
							Interaction				0.862911									
							Within	3491.9	54	64.66481										
							Total	12340.18	59											

Advantages of RBD:

- > The precision is more in RBD.
- > The amount of information obtained in RBD is more as compared to CRD. RBD is more flexible. Statistical analysis is simple and easy.
- > Even if some values are missing, still the analysis can be done by using missing plot technique.

Disadvantages of RBD:

➤ When the number of treatments is increased, the block size will increase. If the block size is large maintaining homogeneity is difficult and hence when more number of treatments is present this design may not be suitable.

2^2 Factorial design:

- A 2×2 factorial design is a type of experimental design that allows researchers to understand the effects of two independent variables (each with two levels) on a single dependent variable.
- For example, suppose a botanist wants to understand the effects of sunlight (low vs. high) and watering frequency (daily vs. weekly) on the growth of a certain species of plant.
- Example of a 2x2 factorial designThis is an example of a 2x2 factorial design because there are two independent variables, each with two levels: Independent variable #1: SunlightLevels: Low, HighIndependent variable #2: Watering FrequencyLevels: Daily, WeeklyAnd there is one dependent variable: Plant growth.

- 1)The Purpose of a 2×2 Factorial DesignA 2×2 factorial design allows you to analyze the following effects:
- 2) Main Effects: These are the effects that just one independent variable has on the dependent variable. For example, in our previous scenario we could analyze the following main effects:
- Main effect of sunlight on plant growth.

 Main effect of watering frequency on plant growth.
- 3)Interaction Effects: These occur when the effect that one independent variable has on the dependent variable depends on the level of the other independent variable. For example, in our previous scenario we could analyze the following interaction effects2

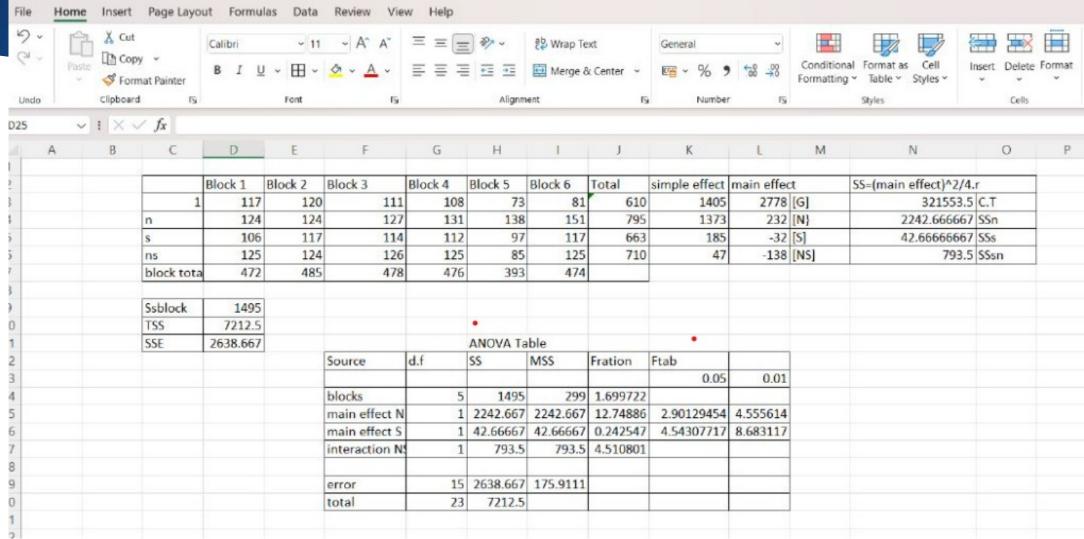
Does the effect of sunlight on plant growth depend on watering frequency? Does the effect of watering frequency on plant growth depend on the amount of sunlight?

Watering Frequency

	Daily	Weekly
	Plant	Plant
Low	Growth	Growth
	Plant	Plant
High	Growth	Growth

Sunlight

202 Factorial design in Excel·



Thank You!