Create Attribute Analysis Worksheet

Gage Repeatability and Reproducibility Study or Measurement System Analysis (MSA)
to quantify errors due to lack of repeatability and reproducibility

Stat -> Quality Tools -> Gage Study -> Create R&R Study Worksheet

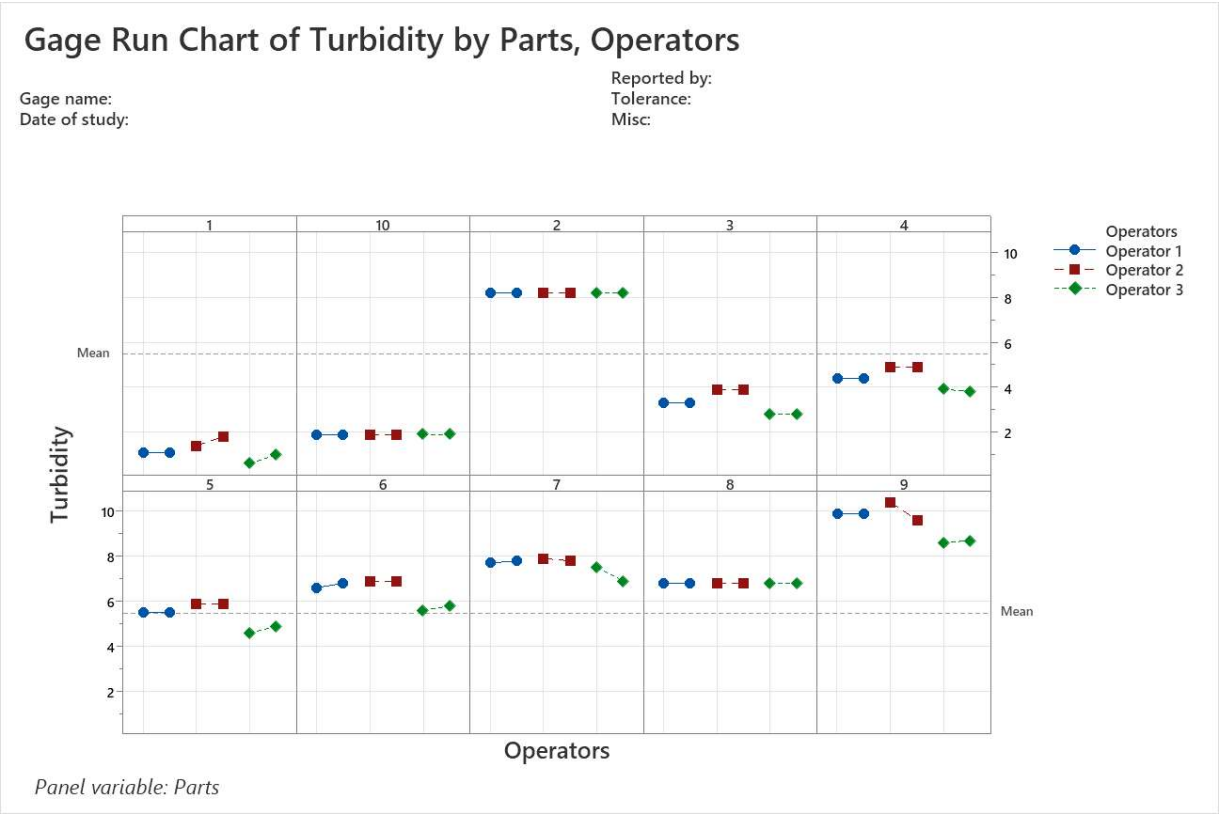
Minimum of 10 items or parts (measurements) are required
Minimum of 2 operators
Minimum of 2 replicates

Options: Randomize runs with the operator

Gage Run Study

To create Gage Study use Create Gage R&R and then save the worksheet. Download worksheet, fill in experimental results and upload back.

Stat -> Quality Tools -> Gage Study -> Create Run Chart



Gage R and R study Crossed

Stat -> Quality Tools -> Gage Study -> Gage R&R Study (Crossed)

Compare Parts vs Operators using Anova

Options - Spec enter 0.5 to 10.5 (for this data)

All results are significant with operators and parts (P is <0.05)

Gage R&R contribution to variance is less than 2.98% = good.
Variance should be less than 10. Between 10 and 20% is acceptable.

There should be more than 5 distinct categories (8 in this example).
Measurement system is valid.

Two-Way ANOVA Table With Interaction

Source	DF	SS	MS	F	P

Parts	9	408.477	45.3863	255.085	0.000
Operators	2	5.537	2.7687	15.561	0.000
Parts * Operators	18	3.203	0.1779	6.977	0.000
Repeatability	30	0.765	0.0255		
Total	59	417.982			

α to remove interaction term = 0.05

Variance Components

Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	0.23125	2.98
Repeatability	0.02550	0.33
Reproducibility	0.20575	2.65
Operators	0.12954	1.67
Operators*Parts	0.07621	0.98
Part-To-Part	7.53473	97.02
Total Variation	7.76598	100.00

Gage Evaluation

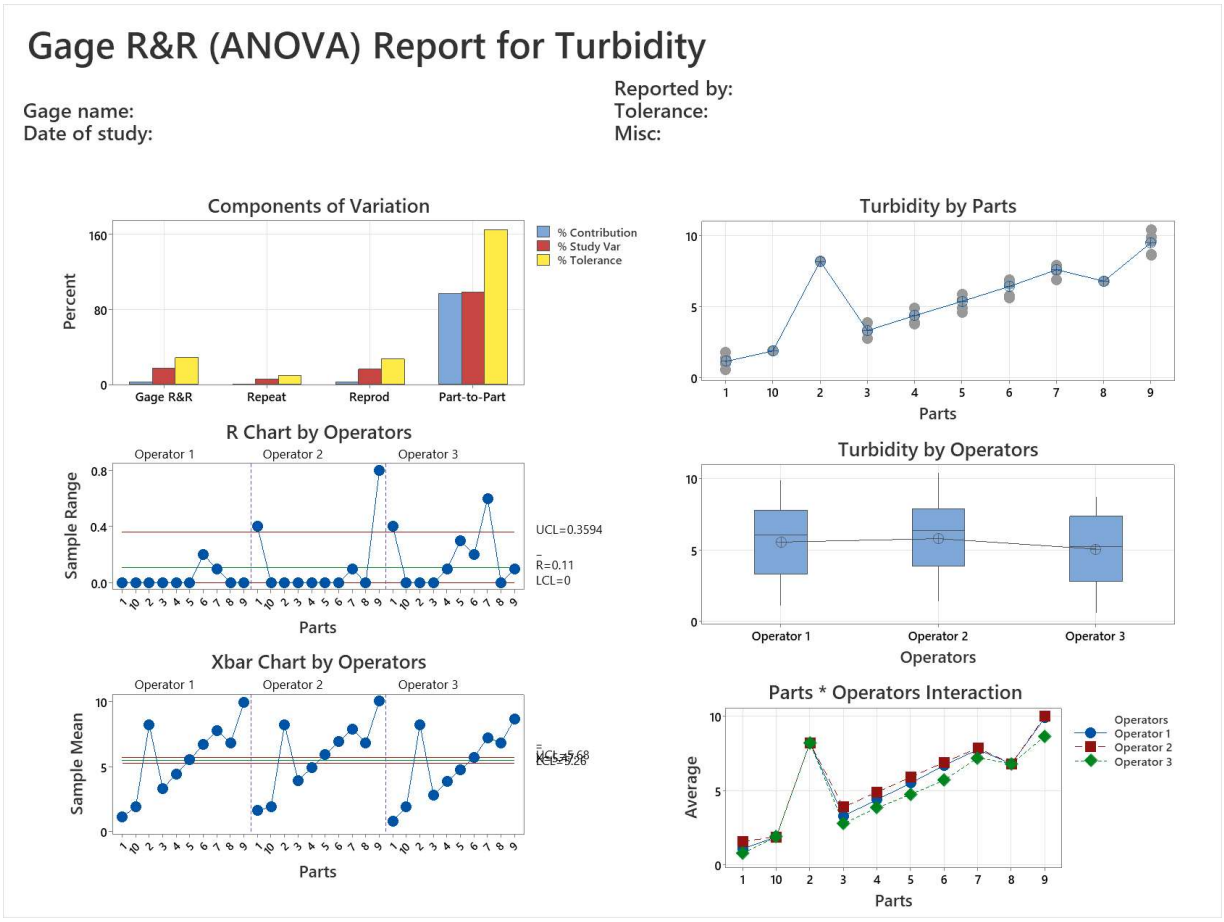
Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)	%Tolerance (SV/Toler)
Total Gage R&R	0.48088	2.8853	17.26	28.85
Repeatability	0.15969	0.9581	5.73	9.58
Reproducibility	0.45360	2.7216	16.28	27.22
Operators	0.35991	2.1595	12.92	21.59
Operators*Parts	0.27607	1.6564	9.91	16.56
Part-To-Part	2.74495	16.4697	98.50	164.70
Total Variation	2.78675	16.7205	100.00	167.21

Joint Probability

Description	Probability
A randomly selected part is bad but accepted	0.009
A randomly selected part is good but rejected	0.013

Conditional Probability

Description	Probability
A part from a group of bad products is accepted	0.127
A part from a group of good products is rejected	0.014



Attribute Agreement Analysis

Run this test to compare appraisers against each other and against a known standard

Stat -> Quality Tools -> Create Attribution Agreement Analysis Worksheet

Options: Randomize the runs
Drop down menu: Sample Standards/Attributes in Text (ie appraiser will record text, such as P fror Pass, F for Fail, etc.)
Fill all the known P and F values in 'Text Standard' column.

Record the actual assessments based by the appraisers in 'Assessments' column C5-T.

RESULTS:
Stat -> Quality Tools -> Attribute Agreement Analysis
Kappa Guidelines
0.90 to 1.0 Excellent
0.75 to 0.89 Capable
0.5 to 0.74 Improve
0.00 to 0.49 Take Immediate Action

Between the free operators Kappa shows that Elaine is capable (0.85) but the other operators need

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
Elaine	15	14	93.33	(68.05, 99.83)
George	15	13	86.67	(59.54, 98.34)
Jerry	15	13	86.67	(59.54, 98.34)

 # Matched: Appraiser agrees with him/herself across trials.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
Elaine	fail	0.856459	0.258199	3.31705	0.0005
	pass	0.856459	0.258199	3.31705	0.0005
George	fail	0.732143	0.258199	2.83558	0.0023
	pass	0.732143	0.258199	2.83558	0.0023
Jerry	fail	0.700000	0.258199	2.71109	0.0034
	pass	0.700000	0.258199	2.71109	0.0034

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
Elaine	15	14	93.33	(68.05, 99.83)
George	15	12	80.00	(51.91, 95.67)
Jerry	15	13	86.67	(59.54, 98.34)

 # Matched: Appraiser's assessment across trials agrees with the known standard.

Assessment Disagreement

Appraiser	# pass / fail	Percent	# fail / pass	Percent	# Mixed	Percent
Elaine	0	0.00	0	0.00	1	6.67
George	0	0.00	1	11.11	2	13.33
Jerry	0	0.00	0	0.00	2	13.33

 # pass / fail: Assessments across trials = pass / standard = fail.
 # fail / pass: Assessments across trials = fail / standard = pass.
 # Mixed: Assessments across trials are not identical.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
Elaine	fail	0.928230	0.182574	5.08412	0.0000
	pass	0.928230	0.182574	5.08412	0.0000
George	fail	0.728507	0.182574	3.99020	0.0000
	pass	0.728507	0.182574	3.99020	0.0000
Jerry	fail	0.850000	0.182574	4.65564	0.0000
	pass	0.850000	0.182574	4.65564	0.0000

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
15	11	73.33	(44.90, 92.21)

 # Matched: All appraisers' assessments agree with each other.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
fail	0.747532	0.0666667	11.2130	0.0000
pass	0.747532	0.0666667	11.2130	0.0000

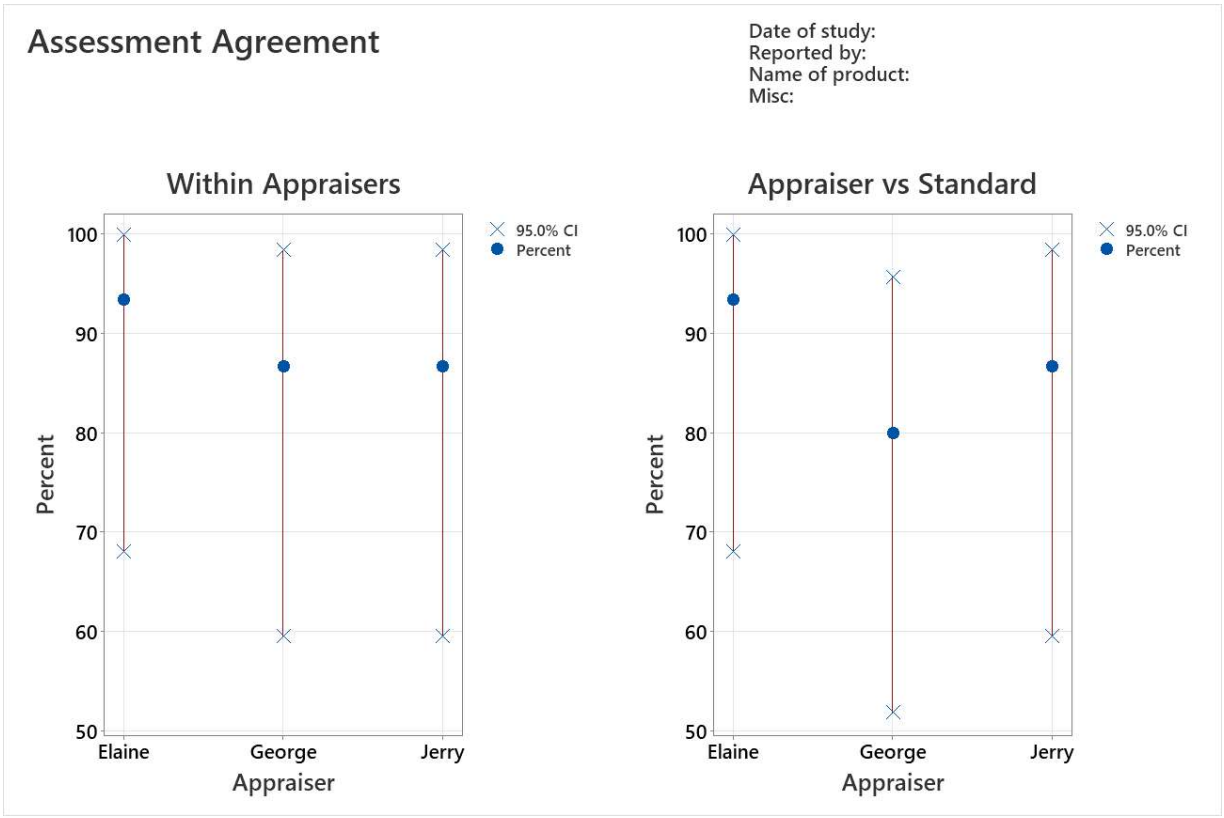
Assessment Agreement

# Inspected	# Matched	Percent	95% CI
15	11	73.33	(44.90, 92.21)

 # Matched: All appraisers' assessments agree with the known standard.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
fail	0.835579	0.105409	7.92700	0.0000
pass	0.835579	0.105409	7.92700	0.0000



Application of Attribute Agreement Analysis

In this MSA study service reps named CSR1, CSR2, CSR3 listened to 10 calls each and classified complaints A through E. They performed 2 rounds of evaluations. Study was blinded.

Data was pre-loaded and analyzed by : **Stat -> Quality Tools -> Attribute Agreement Analysis**
Attributes = Assessments

RESULTS: Percentages of Assessment agreement within and between the appraisers
CSR 1 and 2 have only 70% match and CSR3 has 100% match in calls classification.
Only 60% agreement between the appraisers.

MITIGATION STEPS: Re-train appraiser 1 and 2 and re-evaluate to ensure at least 90% agreement

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
CSR 1	10	7	70.00	(34.75, 93.33)
CSR 2	10	7	70.00	(34.75, 93.33)
CSR 3	10	10	100.00	(74.11, 100.00)

 # Matched: Appraiser agrees with him/herself across trials.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
CSR 1	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	0.20000	0.316228	0.63246	0.2635
	E	-0.17647	0.316228	-0.55805	0.7116
	Overall	0.61290	0.166059	3.69089	0.0001
CSR 2	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	-0.17647	0.316228	-0.55805	0.7116
	E	0.20000	0.316228	0.63246	0.2635
	Overall	0.61290	0.166059	3.69089	0.0001
CSR 3	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	1.00000	0.316228	3.16228	0.0008
	E	1.00000	0.316228	3.16228	0.0008
	Overall	1.00000	0.164383	6.08336	0.0000

Cohen's Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
CSR 1	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	0.28571	0.221313	1.29099	0.0984
	E	0.00000	0.000000	*	*
	Overall	0.63415	0.133813	4.73904	0.0000
CSR 2	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	0.00000	0.000000	*	*
	E	0.28571	0.221313	1.29099	0.0984
	Overall	0.63415	0.133813	4.73904	0.0000
CSR 3	A	1.00000	0.316228	3.16228	0.0008
	B	1.00000	0.316228	3.16228	0.0008
	C	1.00000	0.316228	3.16228	0.0008
	D	1.00000	0.316228	3.16228	0.0008
	E	1.00000	0.316228	3.16228	0.0008
	Overall	1.00000	0.164383	6.08336	0.0000

Assessment Agreement

Appraiser	# Inspected	# Matched	Percent	95% CI
CSR 1	10	7	70.00	(34.75, 93.33)
CSR 2	10	6	60.00	(26.24, 87.84)
CSR 3	10	10	100.00	(74.11, 100.00)

 # Matched: Appraiser's assessment across trials agrees with the known standard.

Fleiss' Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
CSR 1	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	0.56583	0.223607	2.53045	0.0057
	E	0.31111	0.223607	1.39133	0.0821
	Overall	0.80390	0.119309	6.73802	0.0000
CSR 2	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	0.04444	0.223607	0.19876	0.4212
	E	0.17367	0.223607	0.77667	0.2187
	Overall	0.67487	0.119309	5.65652	0.0000
CSR 3	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	1.00000	0.223607	4.47214	0.0000
	E	1.00000	0.223607	4.47214	0.0000
	Overall	1.00000	0.116236	8.60317	0.0000

Cohen's Kappa Statistics

Appraiser	Response	Kappa	SE Kappa	Z	P(vs > 0)
CSR 1	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	0.58042	0.202821	2.86173	0.0021
	E	0.36842	0.152541	2.41523	0.0079
	Overall	0.80769	0.112646	7.17021	0.0000
CSR 2	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	0.10526	0.152541	0.69007	0.2451
	E	0.19580	0.202821	0.96540	0.1672
	Overall	0.67949	0.112646	6.03208	0.0000
CSR 3	A	1.00000	0.223607	4.47214	0.0000
	B	1.00000	0.223607	4.47214	0.0000
	C	1.00000	0.223607	4.47214	0.0000
	D	1.00000	0.223607	4.47214	0.0000
	E	1.00000	0.223607	4.47214	0.0000
	Overall	1.00000	0.116236	8.60317	0.0000

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
10	6	60.00	(26.24, 87.84)

 # Matched: All appraisers' assessments agree with each other.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
A	1.00000	0.0816497	12.2474	0.0000
B	1.00000	0.0816497	12.2474	0.0000
C	1.00000	0.0816497	12.2474	0.0000
D	0.33333	0.0816497	4.0825	0.0000
E	0.33333	0.0816497	4.0825	0.0000
Overall	0.72650	0.0424434	17.1168	0.0000

Cohen's Kappa Statistics

You must have two appraisers and single trial per appraiser to compute kappa.

Assessment Agreement

# Inspected	# Matched	Percent	95% CI
10	6	60.00	(26.24, 87.84)

 # Matched: All appraisers' assessments agree with the known standard.

Fleiss' Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
A	1.00000	0.129099	7.7460	0.0000
B	1.00000	0.129099	7.7460	0.0000
C	1.00000	0.129099	7.7460	0.0000
D	0.53676	0.129099	4.1577	0.0000
E	0.49493	0.129099	3.8337	0.0001
Overall	0.82626	0.068297	12.0981	0.0000

Cohen's Kappa Statistics

Response	Kappa	SE Kappa	Z	P(vs > 0)
A	1.00000	0.129099	7.7460	0.0000
B	1.00000	0.129099	7.7460	0.0000
C	1.00000	0.129099	7.7460	0.0000
D	0.56189	0.112746	4.9837	0.0000
E	0.52141	0.112746	4.6246	0.0000
Overall	0.82906	0.065734	12.6123	0.0000