

Six Sigma Statistics using Minitab 17

Green Belt Edition

11 Evaluation of Measurement Systems Answers to Exercises

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Exercise 11.13.1

Gage R&R Crossed

A Gage R&R study has been conducted with 3 operators, 3 repeats and 14 parts. The study does not have a historical StDev or Tolerance. Form a Gage run chart and then conduct the analysis of the Gage R&R Study and then answer the questions shown below.

The data in File 12 MSA.xlsx worksheet Exercise1.

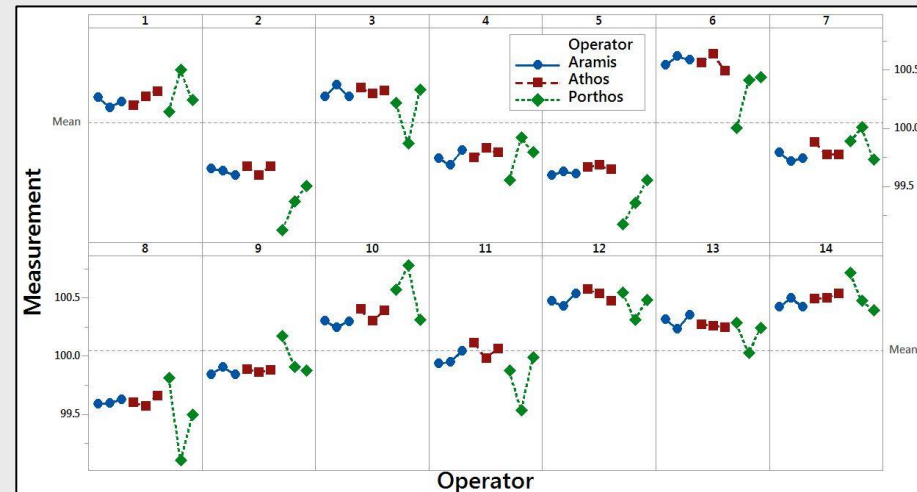
- 1) Does the Gage Run Chart indicate any particular types of problem?
- 2) How is the measurement system rated?
- 3) What is the biggest issue for the study, is it repeatability or reproducibility?
- 4) If there are repeatability issues who is causing them?
- 5) Are there any other issues?

Set-up

1. Click Stat<<Quality Tools<<Gage Study<<Gage Run Chart
2. Enter the column headings as shown into the main menu.
3. Click OK to execute the procedure.

Part numbers:	Part
Operators:	Operator
Measurement data:	Measurement

Analysis-I



Porthos is having repeatability issues. He is probably causing reproducibility issues with the other operators. I would estimate that repeatability is more of an issue than reproducibility.

Set-up2

1. Click Assistant<<Measurement System Analysis
2. Click on the Gage R&R Study (Crossed) box which is used for continuous data.
3. The test menu opens. Enter the data columns into the menu as shown.
4. In the Process Variation section click on the radio button to estimate process variation from parts in the study.
5. Click OK to execute the procedure.

Measurement data

Operators:

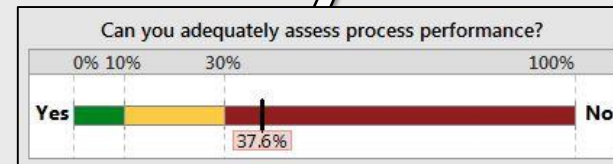
Parts:

Measurements:

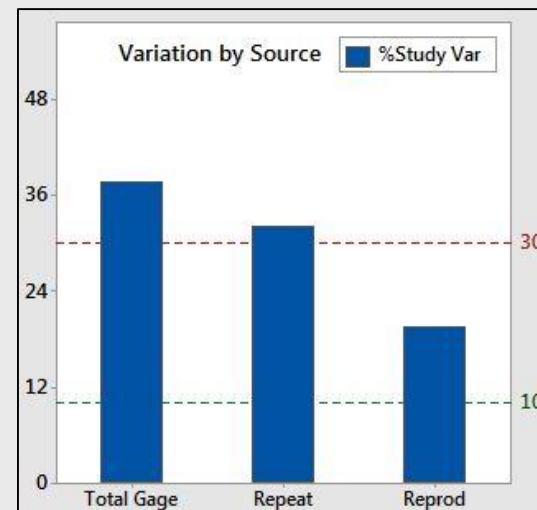
☐ Use historical standard deviation

☒ Estimate from parts in the study

Analysis-2

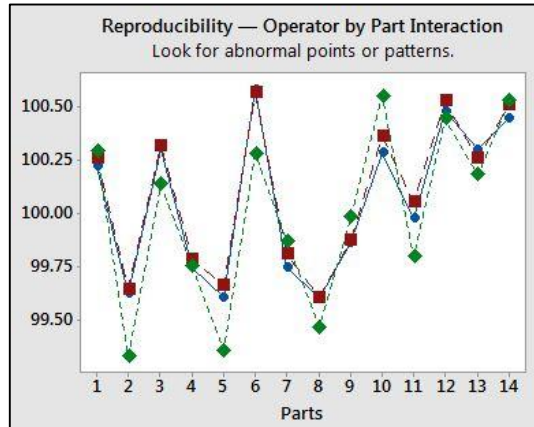


Starting on the top left of the Summary Report, the decision bar indicates that the measurement system is unacceptable as it contributes 37.6% of the observed variation.

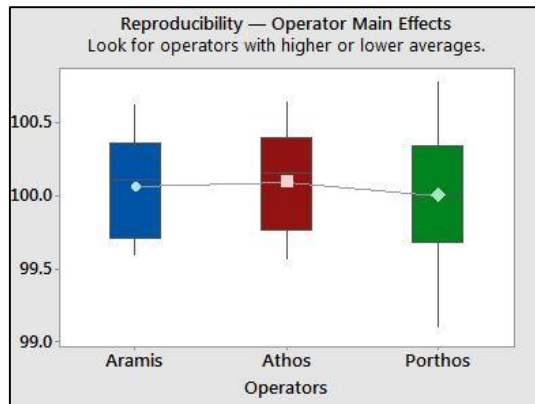


The Variation by Source Chart shows that the biggest issue for this study is repeatability.

Analysis-3



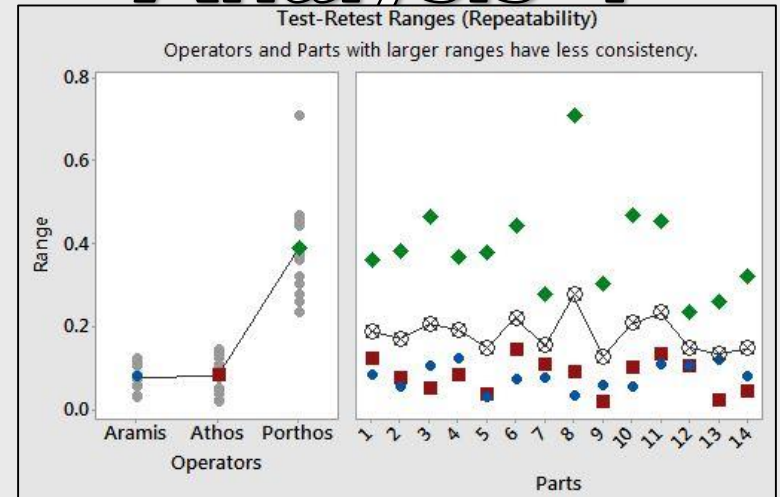
On the Variation Report the Operator by Part Interaction plot shows Aramis and Athos agree fairly consistently but Porthos's measurements contain more variation.



The Operator Main Effects plot shows the Porthos's is measuring at slightly lower average value than the others. The higher spread in his measurement can also be seen.

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Analysis-4



The Retest Ranges plot shows the evident repeatability issue shown in terms of measurement range. Porthos had even more problems with part 8.

Source	StDev	%Study Variation
Total Gage	0.147	37.62
Repeatability	0.126	32.13
Reproducibility	0.077	19.57
Operator	0.038	9.64
Operator by Part	0.067	17.03
Part-to-Part	0.363	92.65
Study Variation	0.391	100.00

The study table shows that there was a significant operator part interaction. This means that one or more of the operators ability to measure is dependant upon the part he is measuring.

Example 11.13.2

Conduct an Attribute Agreement Analysis

Data collection for an Attribute Agreement Analysis has been conducted with 3 operators, 2 repeats and 40 parts. Conduct the analysis and answer the questions shown below and then answer the questions shown below.

The data in File 11 MSA.xlsx worksheet Exercise2.

- 1) How is the good appraisal system?
- 2) Are any of the Appraisers different from the other Appraisers?
- 3) Are any of the parts difficult to appraise?
- 4) Are the appraisers failing more good parts or passing bad parts?

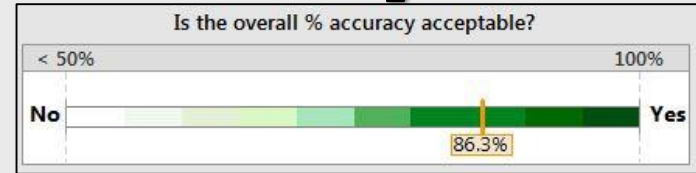
Set-up

1. Click Assistant<<Measurement System Analysis
2. Click on the Attribute Agreement Analysis box which is used to assess appraisers.
3. Complete the menu as shown and click on OK to execute the procedure.

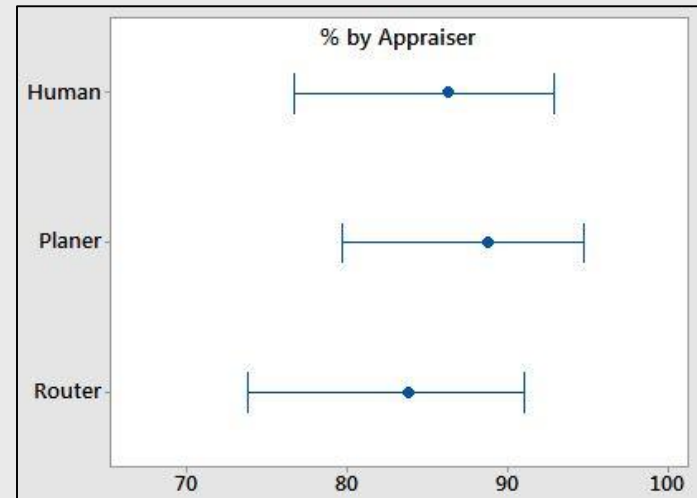
Enter the columns containing the following:

Appraisers:	Appriaser
Trials:	(optional)
Test items:	Part
Appraisal results:	'Appraisal Result'
Known standards:	Standard
Value of good or acceptable items:	Good

Analysis-I

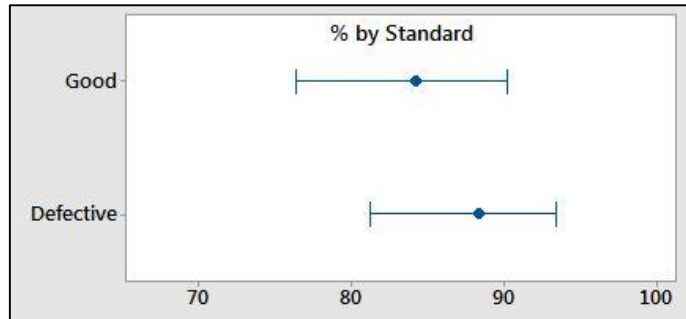


On the Summary Report, the accuracy rating is 86.3% and this sounds good but we can't tell if the Appraisal system is good as there are no standard values for acceptance.



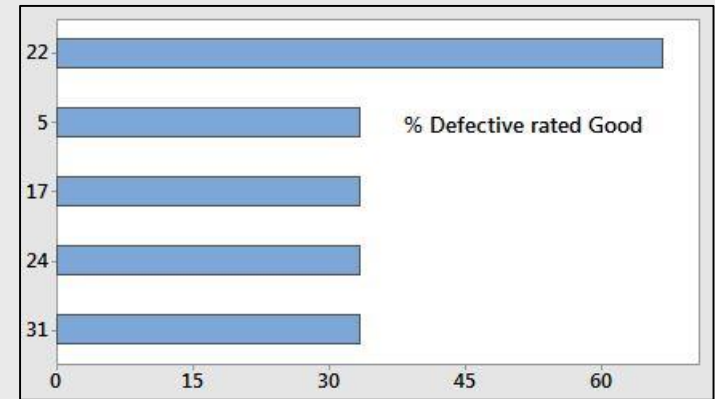
On the Accuracy Report we can see that the 95%CI's for the Appraisers overlap so we cannot say that any of them are measuring differently.

Analysis-2



On the Accuracy Report we see that the 95%CI's for the accurate appraisal for good and bad parts overlap so we cannot say that they are different.

Analysis-3



From the Misclassification report it would appear that part 22 is difficult to appraise. It keeps getting rated good when it is defective.