INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 5)
Available online at: www.ijariit.com

Gauge repeatability and reproducibility study in a mechanical workshop

V. Chaithanya Raam
calmraam97@gmail.com
Meenakshi Sundararajan Engineering College, Chennai, Tamil Nadu

M. S. Amrish
msamrish7@gmail.com
Meenakshi Sundararajan Engineering College, Chennai, Tamil Nadu

S. Naveen Kumar
snaveenkumar97@gmail.com
Meenakshi Sundararajan Engineering College, Chennai, Tamil Nadu

R. Jayashruthi
jayashruthi.rangarajan@gmail.com
Meenakshi Sundararajan Engineering College, Chennai, Tamil Nadu

Arul V.
8789arul.v@gmail.com
Meenakshi Sundararajan Engineering College, Chennai, Tamil Nadu

ABSTRACT

Organizational success depends upon the reliable measurement system that is being used in the organization and also the workers' efficiency in measuring the object. Gauge Repeatability and Reproducibility (GRR) study is used to assess the measurement system and the workers' efficiency in measuring the instruments. This paper demonstrates the application of GRR study in a Mechanical workshop, where measurement (External diameter) of 5 different objects is measured with the measuring instrument (Vernier Caliper) by 3 different operators. Using Minitab, the GRR study is done. Finally, the findings of the study are stated in the conclusion.

Keywords— *MSA: Measurement System, Vernier Caliper, GRR: Gauge Repeatability and Reproducibility, Minitab, Quality Control, Measurement Reliability*

1. INTRODUCTION

A gauge is a measuring tool which is used to measure some physical attribute of the product. This gauge is being used by the line workers to assess the dimensional quality of the product. Gauge R&R is used to understand how the interaction of the product, gauge and user can influence variation in measurements. Repeatability refers to the measurements obtained by one person using one gauge. Reproducibility refers to the variation of the measurements due to different workers using the same gauge. Part-to-part variation, repeatability and reproducibility are the 3 different kinds of source variation. Part-to-part variation is the normal range over which measurements are made. Repeatability is the variation caused because of the gauge itself, while reproducibility is the variation because of different operators using the gauge. Repeatability and reproducibility together are called "measurement error" and are measured as "GAUGE R&R". A gauge R&R study will let us know that if the measurement system is acceptable for its intended use.

2. STUDY PROCEDURE

The objects chosen for undertaking the GRR study are as follows:

Fig. 1: Object 1

Fig. 2: Object 2

Fig. 3: Object 3

Fig. 4: Object 4

Fig. 5: Object 5

We chose the above 5 objects for the GRR study and when you look at these objects you get to notice that it has contour profile so we decided to measure the maximum external diameter of the objects. For measuring the external diameter we had 3 operators (V.Chaithanya Raam, M.S.Amrish and Naveen Kumar). And the measuring instrument that we chose to measure the objects is Vernier Caliper.

We chose the above 5 objects for the GRR study and when you look at these objects you get to notice that it has contour profile so we decided to measure the maximum external diameter of the objects. For measuring the external diameter we had 3 operators (V.Chaithanya Raam, M.S.Amrish and Naveen Kumar). And the measuring instrument that we chose to measure the objects is Vernier Caliper.

Now each Object is measured 3 times by a single operator and the mearurements are recorded. The recorded measurements are listed in the table 1. After listing the measurements the measurements are updated in the Minitab Software for to commence with the GRR study.

Table 1: External Diameters of all the 5 objects

Run Order	Object	Operator	Outside DIA (mm)
1	Object 1	Amrish	25.45
2	Object 1	Chaithanya Raam	25.5
3	Object 1	Naveen	24.5
4	Object 2	Amrish	26.25
5	Object 2	Chaithanya Raam	25.25
6	Object 2	Naveen	25.3
7	Object 3	Amrish	25.5
8	Object 3	Chaithanya Raam	25.15
9	Object 3	Naveen	25.15
10	Object 4	Amrish	22.45
11	Object 4	Chaithanya Raam	23.2
12	Object 4	Naveen	23.45
13	Object 5	Amrish	12.44
14	Object 5	Chaithanya Raam	12.45
15	Object 5	Naveen	12.45
16	Object 1	Amrish	24.46
17	Object 1	Chaithanya Raam	25.5
18	Object 1	Naveen	24.4
19	Object 2	Amrish	26.45
20	Object 2	Chaithanya Raam	25.3
21	Object 2	Naveen	25.15
22	Object 3	Amrish	25.15
23	Object 3	Chaithanya Raam	25.5
24	Object 3	Naveen	25.2
25	Object 4	Amrish	22.45
26	Object 4	Chaithanya Raam	23.6
27	Object 4	Naveen	23.4
28	Object 5	Amrish	11.45
29	Object 5	Chaithanya Raam	12.48
30	Object 5	Naveen	12.48
31	Object 1	Amrish	25.45
32	Object 1	Chaithanya Raam	25.5
33	Object 1	Naveen	24.25
34	Object 2	Amrish	25.35
35	Object 2	Chaithanya Raam	25.3

36	Object 2	Naveen	25.35
37	Object 3	Amrish	25.5
38	Object 3	Chaithanya Raam	25.1
39	Object 3	Naveen	25.5
40	Object 4	Amrish	22.5
41	Object 4	Chaithanya Raam	23.2
42	Object 4	Naveen	23.42
43	Object 5	Amrish	11.46
44	Object 5	Chaithanya Raam	12.4
45	Object 5	Naveen	12.46

3. GRR STUDY RESULTS AND INTERPRETATION

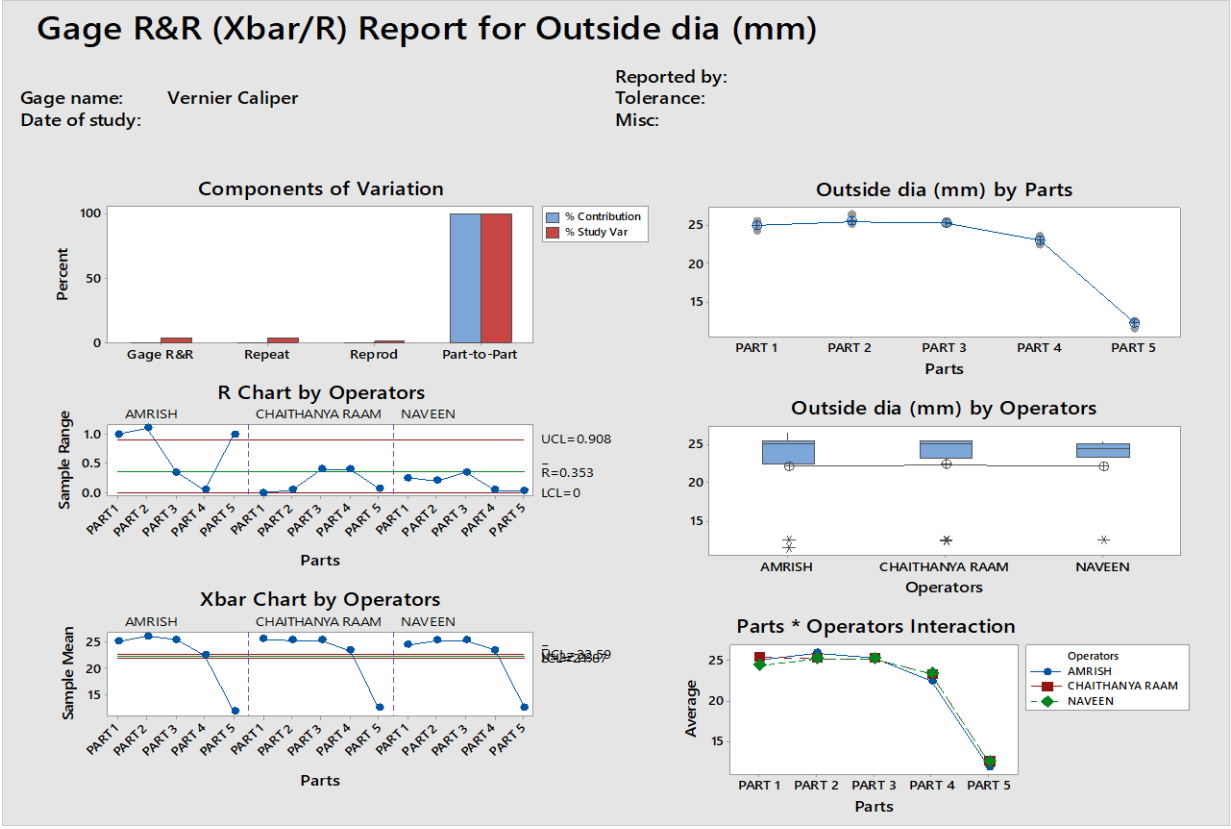

Fig. 6: GRR Report

Variance Components

Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	0.0516	0.18
Repeatability	0.0426	0.15
Reproducibility	0.0090	0.03
Part-To-Part	28.6984	99.82
Total Variation	28.7500	100.00

Fig. 7: Variance Components Table

Gage Evaluation

Source	StdDev (SD)	Study Var (6 × SD)	%Study Var (%SV)
Total Gage R&R	0.22722	1.3633	4.24
Repeatability	0.20647	1.2388	3.85
Reproducibility	0.09486	0.5691	1.77
Part-To-Part	5.35709	32.1425	99.91
Total Variation	5.36191	32.1714	100.00

Fig. 8: Gauge Evaluation Table

3.1. Interpretation from Components of variation Graph

This graph shows whether the largest of component of variation is Object-to-Object variation. In an acceptable measurement system, the largest component of variation is Object-to-Object variation and from the graph is evident that Object to Object variation is the largest.

3.2. Interpretation from R chart by operators Graph

This graph shows whether any points fall above the upper control limit. If the operators measure consistently, the points will fall within the control limits. Here from the graph it is evident that Amrish measures the OBJECTs inconsistently.

3.3. Interpretation from X bar by operator's chart Graph

Shows whether most points fall beyond the control limits. The Object's that we chose for this gage R&R study represent the typical Object-to-Object variability. Thus, the graph shows more variation between Object averages, and in the graph most points fall beyond the control limits.

3.4. Interpretation from outside Día (mm) by Object's Graph

Shows whether multiple measurements for each Object are close together. Here the graph shows that multiple measurements for each Object are close together and this indicates small variation between the measurements of the same Object.

3.5. Interpretation from outside Día (mm) by operators Graph

Shows whether differences between operators are small compared to the differences between Objects. A somewhat straight horizontal line across operators indicates that the mean measurements for each operator are somewhat similar. Ideally, the measurements for each operator vary an equal amount.

3.6. Interpretation from the operator*Objects interaction graph

The graph shows that lines that are nearly coincident which indicates that the operators measures similarly.

3.7. Interpretation from Variance Components table

The %Contribution for Object-to-Object variation is 99.82%. Minitab divides the Object-to-Object variance component value, approximately 28.2986, by the total variation, approximately 28.7500, and multiplies by 100%. When the %Contribution from Object-to-Object variation is high, the measurement system (Vernier Calliper) can reliably distinguish between Objects.

3.8. Interpretation from Gage Evaluation table

The %Contribution for Object-to-Object variation is 99.91 Minitab divides the Object-to-Object study variance component value, approximately 34.1425, by the total variation, approximately 32.1714, and multiplies by 100%. When the %Contribution from Object-to-Object variation is high, the measurement system (Vernier Calliper) can reliably distinguish between Objects.

4. CONCLUSION

The crossed Gage R&R study has provided a comprehensive assessment of the measurement system for the outside diameter measurement. With the Number of Distinct Categories = 5, the system meets the minimum acceptance criteria for a measurement used to study the process. Since Object to Object were the strongest contributors to the measurement variation, the measurement system reliably distinguishes between the Objects. Comparing the operator's reproducibility and repeatability the reproducibility has the highest %contribution to variation than the repeatability so this indicates that among the 3 operators Amrish measured the component inconsistenly which resulted in a Operators reproducibility problem. Identifying ways to make the operator to take proper dimensions using the Vernier Caliper will reduce variation in the system.

5. REFERENCES

[1] Praynay kumar, 2018, Gage R&R Study (Crossed) in Minitab, Advance Innovation Group, viewed 1 September2019, https://www.adavanceinnovationgroup.com

[2] Denise Coleman, 2015, Variable Gage R&R with Minitab, Lean Six Sigma Cooperation, viewed 1 September 2019, https://www.leansixsigmacooperation.com

