Practical Tools

for
Continuous Improvement

Volume One
Statistical Tools

A publication of PQ Systems, Inc.

Operational definition

Operational Definition

What is it?

An operational definition, when applied to data collection, is a clear, concise detailed definition of a measure. The need for operational definitions is fundamental when collecting all types of data. It is particularly important when a decision is being made about whether something is correct or incorrect, or when a visual check is being made where there is room for confusion. For example, data collected will be erroneous if those completing the checks have different views of what constitutes a fault at the end of a glass panel production line. Defective glass panels may be passed and good glass panels may be rejected. Similarly, when invoices are being checked for errors, the data collection will be meaningless if the definition of an error has not been specified. When collecting data, it is essential that everyone in the system has the same understanding and collects data in the same way. Operational definitions should therefore be made before the collection of data begins.

Operational definitions apply to far more than data collection. They apply in a more general sense where they define meaning. For example, what constitutes "on-time" delivery of goods? For some organizations, "on time" is a particular month, week, day, or even a particular time of day. Operational definitions form an essential part of the agreement between customers and suppliers. Deming observed, "In the opinion of many people in industry there is nothing more important for transaction of business than use of operational definitions. It could also be said that no requirement of industry is so much neglected."[1] The aim of an operational definition is clear communication among everyone. A good operational definition generates a consistent meaning that everyone understands.

[1] W. Edward Deming, *Out of the Crisis* (Cambridge: Massachusetts Institute of Technology, 1989, sixth printing), p.276.

WHAT DOES IT LOOK LIKE?

Below are two examples of operational definitions.

In the first example, a team is measuring delays when completing preventative maintenance of buses.

1. **Characteristic of interest:** Delay during the preventative maintenance of buses.
2. **Measuring instrument:** The 24-hour wall clock in the maintenance office will be used. The clock will be calibrated weekly with the "speaking clock" service provided by the telephone system. The check will occur each Monday at 6 AM. No other watches or clocks of any kind are to be used.
3. **Method of test:** When a bus is admitted for maintenance, write down the start time and the scheduled finish time. On completion of the maintenance, write down the actual finish time. Write all times in hours and minutes.
4. **Decision criteria:** If the actual finish time is the same or earlier than the scheduled finish time, record that there was no delay. If, however, the actual finish time is after the planned finish time, record the difference between the times in hours and minutes.

The second example defines a check completed on fuel gauges after they have been assembled. The definition defines the check at the empty position.

1. **Characteristic of interest:** The empty position of a fuel gauge.
2. **Measuring instrument:** The fuel gauge is checked at the test rig on the work station. Normal eyesight is used (with corrective lenses, if normally worn), under the light available at the work station (in 100 percent working order; that is, no burned-out bulbs).
3. **Method of test:** Place the fuel gauge into the test rig, and ensure that the connectors are fully clamped to the gauge. Switch the test rig to the empty fuel position.
4. **Decision criteria:** When switched to the empty position, the needle indicator on the fuel gauge must be at or between the positions shown in figure A. Note: the needle must be touching at least part of the "E," but must not cover any part of the shaded area above the "E." Figure B shows examples of fuel gauges that fail this test.

Figure A - correct position

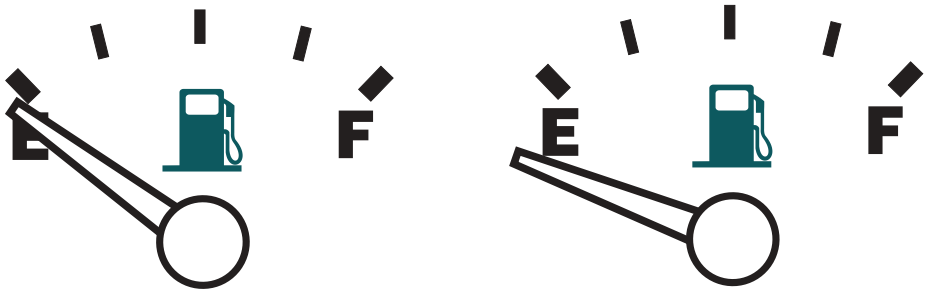
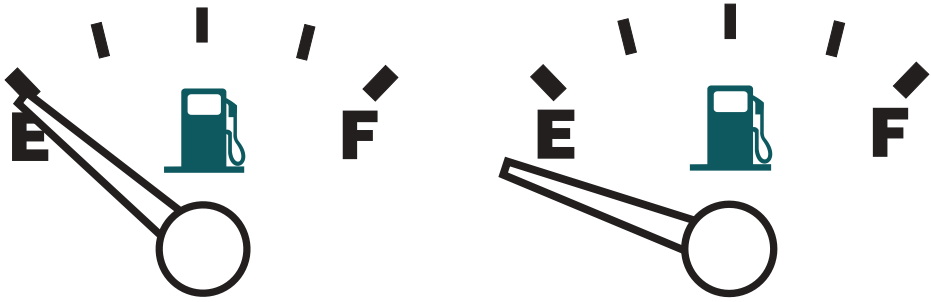


Figure B - incorrect position



When is it used?

Any time data is to be collected.
Any time data is being collected, it is necessary to define how to collect the data. Data that is not defined will usually be inconsistent and will give an erroneous result. It is easy to assume that those collecting the data understand what and how to complete the task. However, people have different opinions and views, and these will affect the data collection. The only way to ensure consistent data collection is by means of a detailed operational definition that eliminates ambiguity.

How is it made?

1. Identify the characteristic of interest.

In the first example, the team wanted to establish the extent of delays in preventative maintenance of buses. The team wanted to know specifically how much time was lost due to the delays. Therefore, the characteristic of interest is "delay during the preventative maintenance of buses."

The second example is from the checks completed on a fuel gauge. When the gauge is assembled, the empty, half-full, and full positions are checked. The second example is the operational definition for the empty position. Therefore, the characteristic of interest is "the empty position of a fuel gauge." Operational definitions for the half-full and full positions have also been completed.

2. Select the measuring instrument.

The measuring instrument is usually either a physical piece of measuring equipment such as a micrometer, weighing scale, or clock; or alternatively, a visual check.

In the first example, a clock is used to measure the time. The operational definition states that only the maintenance office clock is to be used, eliminating inaccuracies associated with personal watches. To ensure that the maintenance clock is accurate, a calibration procedure has been stated. Every Monday at 6 AM the time will be cross-checked with the speaking clock on the telephone system. It is essential that the calibration of the equipment being used is known. The clock in the maintenance office is a 24-hour clock. This eliminates any ambiguity that could occur in terms of AM and PM times.

In the second example, a test rig and visual check are used. The test rig is calibrated as part of the organization's normal calibration procedures, and is outside this operational definition. Whenever a visual check is used, it is necessary to state whether normal eyesight is to be used or a visual aid such as a magnifying glass. In the example, normal eyesight is sufficient. On some occasions, it may also be necessary to state the distance the observer should be from the item being checked. In general, the closer the observer, the more detail will be seen. In the example, a clear visual indication is given of acceptable and unacceptable, so the observer needs to be in a position where the decision can be made. When completing a visual check, the type of lighting may also need to be specified. Certain colors and types of light can make defects more apparent. In the example, the work station has been especially created for the test, and has been created with the appropriate lighting. It is therefore necessary only to ensure that the bulbs are working.

3. Describe the test method.

The test method is the actual procedure used for taking the measurement.

When measuring time, as in the first example, the start and finish points of the test need to be specified. When taking any measurement, the degree of accuracy also needs to be stated. For instance, it is important to know whether time will be measured in hours, minutes, or seconds. In the example, the team decided to measure to the nearest minute.

The second example involves fitting the gauge to the test rig and setting the rig to the correct position for the check.

4. State the decision criteria.

The decision criteria represents the conclusion of the test. Does the problem exist? Is the item correct?

In the first example, a delay is defined as, “when the actual finish time is after the planned finish time.” If this is the case, a delay has occurred and the extent is recorded in hours and minutes.

Since the second example is a visual test, it requires more detail. Whenever a visual check is used, a clear definition of acceptable versus unacceptable is essential. Physical examples or photographs of acceptable and unacceptable, together with written support, are the best definitions. In the second example, drawings are provided to define the position of the needle clearly, for both acceptable and unacceptable positions. The words support the pictorial representation to ensure that the user fully understands the check.

5. Document the operational definition.

It is important that the operational definition is documented and standardized. Definitions should be included in training materials and job procedure sheets. The results of steps 1 through 4 should be included in one document. The operational definition and the appropriate standards should be kept at the work station.

6. Test the operational definition.

It is essential to test the operational definition before implementation. Input from those that are actually going to complete the tests is particularly important. The operational definition should make the task clear and easy to perform. The best way to test an operational definition is to ask different people to complete the test on several items by following the operational definition. Watch how they perform the test. Are they completing the test as expected? Are the results consistent? Are the results correct?

In the first example, the team trained other members of the maintenance staff. Then the team monitored the staff to ensure they were completing the test consistently to the definition.

Testing the second example was simpler. Ten fuel gauges with needles at different empty positions were used. Some of the gauges were acceptable, some unacceptable. Nine operators completed the checks on the gauges using the operational definition. All the operators passed and failed the gauges correctly. The organization can be sure that the operational definition is robust and makes the task clear.

Applications

All data collected for ***control charts***[2], ***Pareto diagrams***, and ***check sheets***, as well as many other terms used in business, require operational definitions.

All industries

- As soon as possible
- On time
- Customer expectations
- Types of customer complaints
- Causes of delays in customer orders
- Types of safety incidents/accidents
- Lost time work injury
- Absenteeism
- Completed sales demonstration
- Audit nonconformity for ISO 9000, ISO 14000, or safety
- Document errors

Administration

- Types of customer orders
- Types of credit notes/invoice changes
- Types of inquiries to accounts payable
- Types of expense into the different company accounts
- Types of inquiries to accounts receivable
- Problems in the purchasing system
- Types of technical calls to the help desk
- Types of documents retrieved from archives
- Incomplete documentation
  For example: purchasing requests, purchase orders, invoices, order forms
- Types of document errors
  For example: letters, invoices

[2] Items that appear in bold italics refer to other tools in this book.

Manufacturing

- On-time delivery of a product
- Expected quality of a product
- Nonconformities
  For example: scratch, dent
- Color of a product
- Surface finish on a product
  For example: consistency, sheen, scratch
- A faulty product that should be: scrapped, reworked
- Product errors
- Document errors
- Labelling errors
- Categories of equipment down time
- Types of warranty claims
- Drawing errors
- Printing errors

Service

- On-time delivery of a service
  For example: train, plane, or bus
- Expected quality of a service
- Cleanliness standards
  For example: trains, planes, buses, taxis, streets, airports, shopping malls
- Reasons for delay in a service
  For example:
  - Registering in a hotel
  - Renting a car
  - Repairing a car
  - Responding to an emergency call
  - Booking theatre/plane tickets
  - Processing a bank loan
  - Processing an insurance claim
  - Solving a technical inquiry
  - Taxi arrival
  - Room service arrival
  - Package delivery
- Document errors
  For example: leases, deeds, tax returns
- Incomplete documents
- Types of technical calls

Remember

1. Operational definitions help reduce the variability in data collection.
2. Operational definitions are required for all types of data.
3. Operational definitions are used *before* data is gathered.

Getting the most from operational definitions

Operational definitions are an essential element of collecting reliable data. Before one concludes that an unstable control chart indicates an unstable process, operational definitions and other data collection practices should be checked for validity. A chart that appears to show a process shift or intermittent special causes may be indicating a problem with the operational definition being used. Has the definition changed? Is it still relevant to the process? Have operators been adequately trained in applying the definition?

Operational definitions also provide an excellent communication tool between a supplier and customer. Agreeing on specifications is one way customers and suppliers can use operational definitions. In manufacturing, it is difficult to move to supplier validation, supplier certification, and ship-to-stock without clear operational definitions. A major automotive company invested eighteen months work with its service departments, clarifying operational definitions to allow customers to select the correct department for repairs. This system reduced delays for customers, saved time for personnel, and assured that service was being provided by the proper group.