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Statistical Tools in Project Management

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Abstract: **The article covers different statistical tools that can be used in project management. It analyses the use of statistical tools from project management prospective. Finally, there is a comparison made on the different statistical tools according to their use in project management.**

Keywords: **statistical tools, project management.**

I. INTRODUCTION

Statistical techniques consist of planning, gathering data, designing, analysing, extrapolating significant interpretations and reporting lookup findings. The statistical analysis makes sense of heaps of unrelated data, thereby creating informative picture of dead data. "Outcomes and inferences are particular only if suitable statistical tests are used"(Ali & Bhaskar, 2016)

The paper aims to acquaint the reader with the statistical equipment that are practised in Project Management.

At their most essential, statistics are investigations of population samples, and the objective is to apply the outcomes from these samples to entire populations. This misleadingly basic idea requires a few critical contemplations, for example the design of the study, selection of the study sample, and choice of statistical test(Winters, Winters, & Amedee, 2010). It has been seen that, a satisfactory learning of insights is important for legitimate utilization of measurable apparatuses in venture administration. Despicable measurable techniques may bring about wrong conclusions which may prompt catastrophe in ventures.

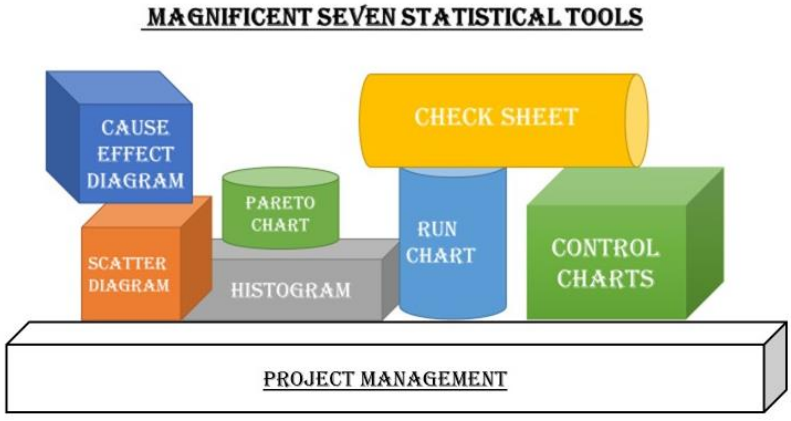
Project Manager construct a unique and simplified model with the motive to get useful results. In so a long way as there is a practical hassle to solve, this model will incorporate positive unknowns, and what is required is to devise the most high-quality technique of acquiring statistics from the records concerning these unknowns.

The Project Management Institute (2004) has identified numerous quality control tools including like cause and effect diagrams, control charts, flowcharts, histogram, Pareto chart, run chart, scatter diagram, statistical sampling, inspection, and defect repair review(PMBOOK)that are helpful in visualization of project aspects, variations and performance.

These quality management tools are helpful in quality control of manufactured products and service-based projects as well. These tools assist the manager during and post project assessment

The tools provided, should satisfy certain stipulations. To get this conclusion, a distinctive set of statistical tools are required. There are seven magnificent statistically tools that can be used in real project management for total quality management(Reddy, Srinivasu, Rikkula, & Rao, 2009) and can be easily realised using Microsoft excel.

Thus, paper demonstrates the use of statistical tools in project management.



Statistics is the science of collecting mathematical or quantitative data, analysing it and getting conclusions out of it. Different statistical tools like cause-effect, pareto chart, check sheet, control charts, histogram, run chart, scatter diagram are applied to data to get conclusions. In project management statistical tools can be helpful for analysing data and project progress.

TOOLS	USAGE IN PROJECT MANAGEMENT
Check Sheet, Control Charts, Scatter Plot, and Cause and effect Diagram	Scope/ Specifications
Check Sheet, Control Charts, Scatter Plot, Cause and effect Diagram, Histogram, Pareto Chart, Defect Concentration Diagram	Time Scheduling, Resource Allocation
Control Charts, Scatter Plot, Cause and effect Diagram, Histogram, Pareto Chart	Cost analyses, Budgeting
Check Sheet, Cause and effect Diagram, Pareto Chart, Defect Concentration Diagram	Risk Analyses, Monitoring And Controlling
Scatter Plot	To check relationship between two variables
Control Charts	To check variations in the process

(Anbari, Carayannis, & Voetsch, 2008)

A. Pareto Charts

The Pareto Chart is a straightforward apparatus that can aid a project manager in better project management. They are superior type of histograms that aims to visualize a "rule" called "*Pareto Principle"*.

The Pareto Principle was discovered by a 19th century Italian economist and sociologist named "*Vilfredo Pareto* (1848 - 1923)". This principle says that, "80% of the outputs result from 20% of the inputs". Thus, Pareto charts can be used to determine those valuable inputs.

The Pareto chart is a bar graph of frequencies arranged in descending order left to right.(Wilkinson, 2006).The chart contains both bars and line graph to show cumulative frequency or scores formed by adding the heights in direction from left to right.

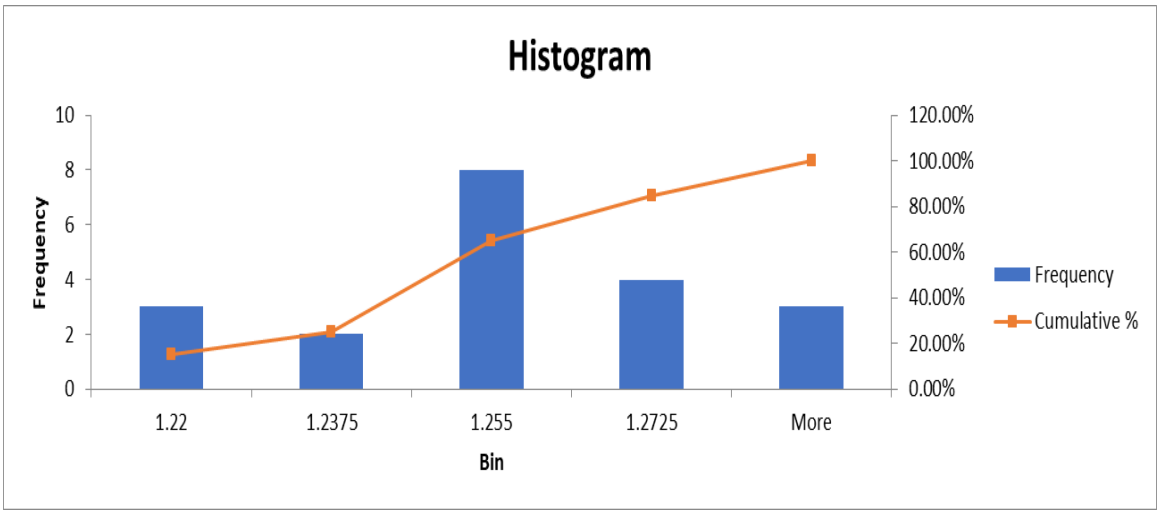


Figure: Pareto chart

Pareto charts have been used in project management, especially Six Sigma, as a useful tool. Microsoft Excel can be used to create Pareto chart in real project management. This chart can be used in quality control situations to categorize critical factors leading to disappointments or imperfections in a method or a process.

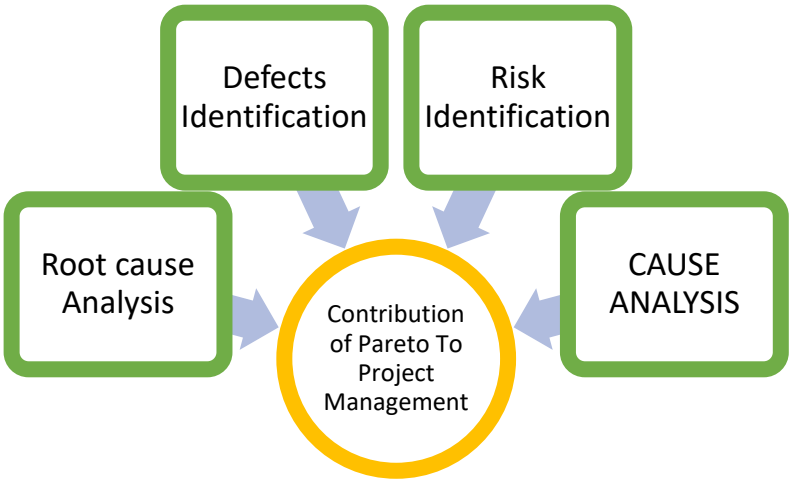


Figure: Pareto chart in Project Management

Defects Identification

Pareto Charts can be used to analyse defects in the Process.(Hossen, Ahmad, & Ali, 2017).Collected data from the process can be plotted in the Pareto Chart to find the highest contribution of defects in the process. It also shows cumulative totals across the graph using a line. After Significant analyses, quality improvement steps can be taken to minimize or remove the defects. The descending graphs further help project manager to analyse most contributing factor in the process.

RISK IDENTIFICATION

Potential causes of risk can be analysed using Pareto Charts. After conducting a cause analysis and obtaining data, risk factors can be plotted on the pareto chart and the one with the highest risk can be dealt first. Thus, risk analyses using pareto chart can be helpful tool for short-term projects, or risk mitigation step in project management.

ROOT CAUSE ANALYSIS

Pareto chart can be used to determine the most significant reason of failure. The cumulative total and the descending bars can be helpful in getting the real problem and its intensity in the process.

B. Check Sheet

Check sheets are extensively used tool in companies for evaluations process. Check sheets are like tally sheets that are utilized with plan-do-check-act in fathoming quality-related issues inside a specific undertaking project plane.

Check Sheets are viable in collecting and inspecting information such as data and facts about project attributes. It can be used for project inspection and auditing. (Snyder, 2014) say that it important to define end goal prior to gathering data so that it will be speedy and can be easily distinguished by the incorporated parameters in check sheet.

It is an effective tool where simple, speedy, and substantial information is needed to be collected. It can be used for both qualitative and quantitative analysis and It is called tally sheet where data is quantitative. The check sheet is one of the seven basic tools of quality control made popular by Dr. Kaoru Ishikawa.("Check Sheets: Five Basic Types," 2013).Further, in the paper we will discuss about the role of check sheet in project management.

	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Monday
Household Work	✓	✓	✓	✓	✓	✓	✓
Classes and Assignments	✓		✓			✓	✓
Job		✓	✓	✓		✓	✓
Entertainment	✓	✓	✓	✓	✓	✓	

Figure: Check sheet

Resource Allocation

Resources are the important part of any project and it is vital to allocate resources considering the time and budget constraint in the project. Thus, check sheet can be devised for all qualitative and quantitative allocation. Moreover, check sheet can also be made in no technology regions, using pen and paper and with no realization this tool is often used in our daily life too.

Time Scheduling

Time is the major constraint of all projects; accordingly, check sheets can be frequently used in project management for time allocation.

Scope Analyses

No project in this world starts without defining the scope of the project, thus, check sheets can be used to finalise scope of the projects.

Monitoring and Controlling

During all the phases of project monitoring and controlling of project is a big task of project manager. So, to check the progress or status before, during and after project process, check sheets can be a rightly used in project management.

C. Histograms

Histograms are graphical depiction of information that is gathered into different sources. It empowers the managers to use the data to choose the efficiency of a venture. It can be useful in determining the breaking points of the project and likewise it can be used in defining the parts of project that needs major attention or examination. This tool can be used to run project simulation in initial phase of the project. Project manager can utilise histogram to analyse current performance and progress over time(Krompholz, 2016).

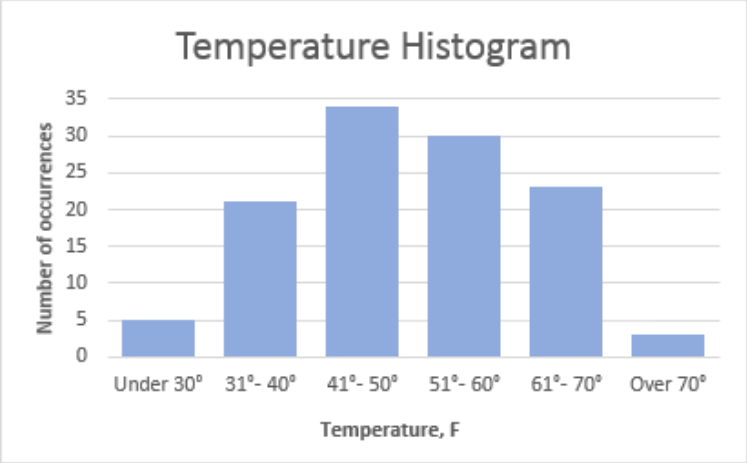


Figure: Temperature occurrence histogram

Optimum Resources Utilization

Optimum resource allocation in the project can be visualised using histogram project demand versus accessible resources.

The histogram **can be useful to** run resources simulations. In the project, the assets can be work force, machine parts, gear, devices, and so forth. The project manager can alter asset allocation based on individual resources available or the time constraints, to any number of situations to perceive how the task proficiency changes. Histogram can likewise give slight prediction of what may happen in the scarcity of asset for example, devices or labour(Clarke, 2012).

(Ghoddousi, Eshtehardian, Jooybanpour, & Javanmardi, 2013) says that, “decreasing the fluctuation in resource usage histogram, project cost mainly increases”. Thus, we can use histogram to analyse project cost during all the phases of project.

Basic Pert and CPM can be used effectively for resources levelling (aims to reduce resource demand variation in the project) and allocation but only when resources and time are not the constraints. But, for small-sized projects ,where resources and time is limited , histogram analyses can be done while dealing with project resources levelling and allocation(Hegazy, 1999).

Analyse Quality

Quality of the project is important for both customer and company reputation in the market and, it is important to analyse quality of the product or service that is supplied during and after the project. Histogram is an easy way to analyse numbers in the project to access its growth and quality.

Analyse Risk

Risk is associated with all the projects even if it has no time and cost constraints. Thus, understanding risk and risk-factors associated with the project is important especially during pre-project phase. Histogram can be helpful tool in graphically analysing project risk, It specifies risk factors and its extent in the project.

Customer Expectations

Voice of customer is the major project specification needed in the project and it is significant for the project manager to serve all the customer demands. Histogram can graphically help both customer and provider in analysing customer expectations and their demands. Moreover, it can also be utilised to analyse time and cost needed to cover all customer expectations.

D. Control Charts

Another tool this paper discusses is the control Charts that can be used to study progress over time and analyse variability. Control chart always have central tendency, upper control limit and lower control limit that helps the project manager determine if the process is under control or not. If data is within Upper and lower limit line, around central line, it is called statistically stable.

In project management, Cost Performance Index (CPI) and Schedule Performance Index(SPI) can be analysed and can be kept on track using control charts.(Sharma, 2013).

Control Charts can be used to control stability, behaviour and predictability in the project management.

Figure: X bar and R bar control Charts

Defects in the process

Control Charts are the important pillars in the project management, as they give ability to the project manager to visualise defective or breaking points in the project, and according to the problem, corrective actions can be taken or applied to prevent added problems.

Control Project variables

Control charts can be used to monitor different project variables such as cost, schedule, scope frequencies etcetera(Snyder, 2014). It helps the project manager to visually check if the process is under control or not. X bar and R bar control charts can be used to check variability and defects in the process.

E. Cause-effect Diagram

Cause and effect diagram is a commonly used tool to analyse risks, risk factors and their consequences. Using proper analyses of risk association and composition, the relationship between risk sources and its effects on project performance can be identified(Tague, 2005). Using this tool time, cost, quality and safety can be visually represented(Carr & Tah, 2001). It is also known as “Ishikawa diagrams”, and flow or systems diagrams that represents the relation amid the system elements and their causality.(Fernández-Sánchez & Rodríguez-López, 2010). There are many techniques to analyse risk such as brainstorming, checklists, interviews, diagramming techniques such as cause effect diagram and risk matrixes. (Hillson, 2002)articulates that there is no “single best method” for risk identification, different appropriate combination of techniques should be used to analyse true causes of risk in the project.

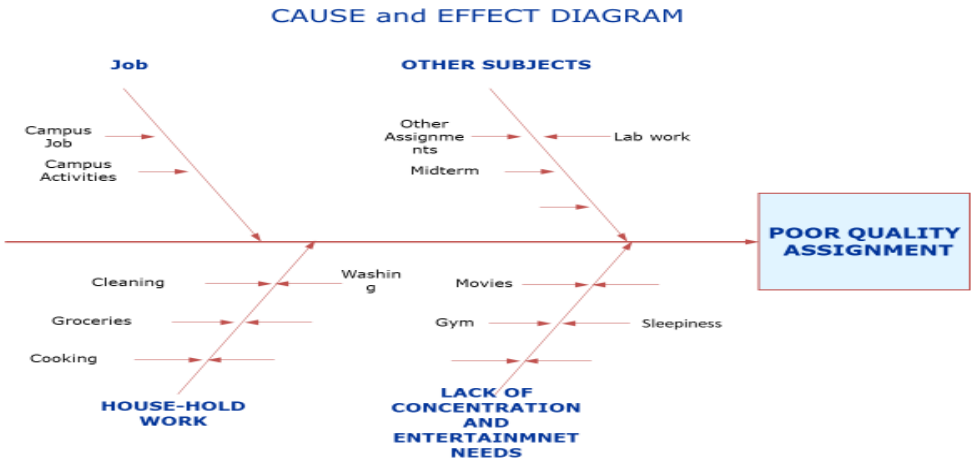


Figure: Cause effect Diagram Showing causes of Poor Quality in assignment

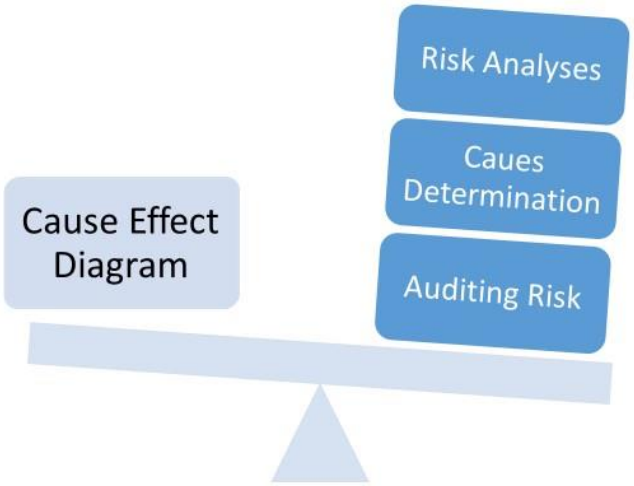


Figure: Cause Effect Diagram in Project Management.

Cause Determination

With the assistance of Pareto graphs, which are for the most part used to distinguish critical zones, the assembling procedure defects in each phase of the production in the project, can be organized by orchestrating them in descending order of significance. At that point circumstances and end results outline is being connected to investigate conceivable causes/variables of imperfections and to decide the causes/factors, which has the best impact.(Ahmed & Ahmad, 2011).

Auditing Risk

Cost effect Diagram (CEM) outlines have been set up for a long time, and are utilized to build up a rationale framework which is set into a circumstances and end results graph in a matrix form. They have been created to assess useful piece outlines and produce circumstances and end results charts for review purposes. Trebelex Program which works under Microsoft Word's DOS framework can be used for these purposes. Trebelex is a manual diagramming apparatus that is basically used to make an interpretation of item rationale to a paper arrangement to give to a seller to production of the framework or for review purposes(Larson, Powers, & Hocker, 2002).These innovations are helpful tool in auditing end goals to examine risky activity in the project.

Risk Analyses

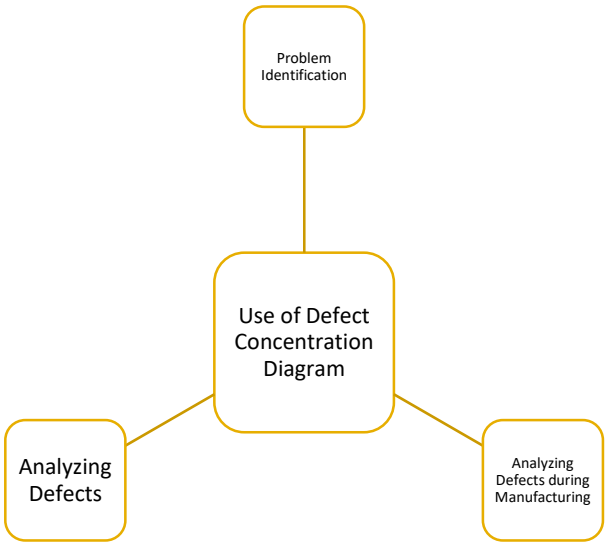
It is a well-recognized and acknowledged tool for risk analysis associated with the project. A successful project manager always study uncertainty accompanying the project to achieve desired objective of the project. Cause and effect diagram has undoubted popularity in risk analysis in the project(Smith, 1998).

The Cause and effect diagram are one of the methodologies for project risk management. This well-known outline is appropriate for the representing conditional probability associated with risks(Han & Diekmann, 2001)in the project and is beneficial when managing complex problems in the process.

But, it is more complex than intuition-based analysis, so it is not widely used risk management methodology(Lee, Park, & Shin, 2009).

F. DEFECT CONCENTRATION DIAGRAM

Defect Concentration Diagram is the pictorial representation of defects in the process or the product. In World War II, partnered engineers utilized defect-concentration diagram to discover where their planes required fortification(Stephanie, 2018). A deformity focus graph was made demonstrating the area of shot gaps in the fuselage of returning planes, and from that designs were made for which parts of the fuselage should have been strengthened.



(Bjørn Andersen, 2015)

Steps to construct

- Define defects or problems in the process.
- Represent all defects into the picture or map of the process.
- Mark all your defects in the map using different symbols or colours.
- Analyse Defects, their root causes and work to minimise it. (Montgomery, 2009)

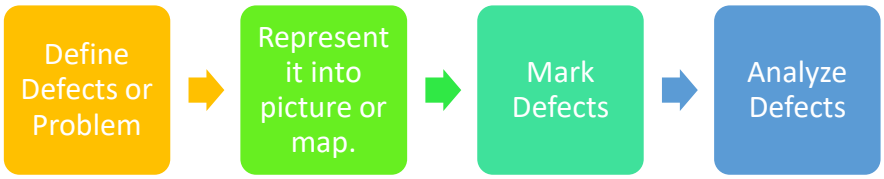


Figure: Steps to draw defect Concentration Diagram

Figure: Defect Concentration Diagram for car window shield

G. SCATTER DIAGRAM

Scatter Plot is one of the magnificent tool used in industries to establish relationship or correlation between two variables(Touchette, MacDonald, & Langer, 1985).It can analyse patterns between reasonable variables and suggest the behaviour or dependence of variables on each other.

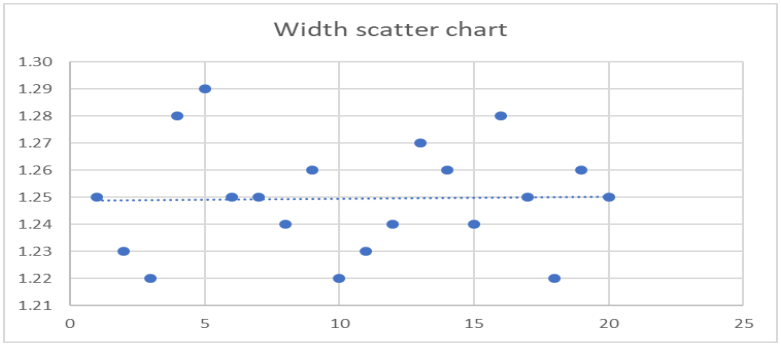


Figure: Width scatter Plot

Figure: Scatter Plot in Project Management

Decision Making

Decision Making is the soul of project management and the success of project is solely dependent on the decisions of project manager. Scatter plots can analyse relationship between different project variables and can help the project head to choose the right path for the project.

Profit Analysis

Input-output graphical relationship using scatter plot can help project manager to predict profit during pre- phase of project. This can also be used to decide investment needed for project. Sometimes, this relationship can also be used to estimate time schedule, KPIV and KPOV of the project.

Scheduling

Time scheduling is important to get success in the project, and time required is dependent on different project variables and constraints. Thus, to help project manager on these different relationships and dependencies, scatter plot can be a very useful tool in project management.

II. CONCLUSION

Performance can be measured in every aspects of life, and numbers are the measure of performance. All projects deal with numbers and to visualise these numbers, their trends and their performance statistical tools can be feasibly used. The table below shows how seven magnificent tools of statistics can be used in the different aspects of project management.

Quality tool or process	Applications in primary triple constraints (scope/specifications, time, cost)	Applications in secondary triple constraints (quality, risk, customer expectations)	Influence on overall project success
Pareto chart	All three constraints	All three constraints	Very strong
Cause and effect diagram	All three constraints	All three constraints	Strong when needed
Flow chart	All three constraints	All three constraints	Moderate
Histogram	All three constraints	All three constraints	Moderate
Check sheet	All three constraints	Quality and risk	Moderate
Control chart	All three constraints	Quality	Moderate when needed
Scatter diagram	All three constraints	Quality	Moderate when needed

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