IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-1, Jan 2019 E-ISSN: 2347-2693

Advanced Charting Techniques of Microsoft Excel 2016 Aiming Visualization

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Available online at: www.ijcseonline.org

Accepted: 20/Jan/2019, Published: 31/Jan/2019

***Abstract*—** Environment of Microsoft Excel integrates storage, analysis and visualization of data. After the data is stored in a precise structured format, further analysis and visualization of data is essential to discover the hidden valuable insight from the large dataset. Visualization supports extracting and understanding the information as it is represented in a graphical format. Visualization plays a vital role in decision making at various levels in the organization. There are numerous techniques of visualization. However, the most extensively used technique is to present the data in a chart format. Various charting techniques such as Column Chart, Pie Chart, Line Chart and Bar Chart are existing in Microsoft Excel application. In addition to these conventional charts, Microsoft Excel 2016 presents six advanced chart types named, Box and Whisker chart, Funnel chart, Histogram chart, Sunburst chart, Treemap chart and Waterfall chart to present the data differently. This paper describes illustrations of new chart types of Microsoft Excel 2016 along with their elements and respective attributes. The purpose of this research paper is to present how advanced charting techniques can be used for visualizing varied data types in the engineering manufacturing industries.

***Keywords*—** Microsoft Excel 2016, Visualization, Charting Techniques, Structured Data.

I. INTRODUCTION

Visualization of the data play a vital role when the precise information and valuable insights are to be extracted from the very large dataset. Identifying the significance of visualization and selecting the appropriate visualization tool and technique is necessary for acquiring the desired result. Numerous data driven decisions are based on the result generated by the visualization tool. While the success of accurate decision making depends upon effective data visualization, the accomplishment of effective data visualization entirely depend on the ability of the tool to visualize.

Visualization is the frontend of data analysis. However, one single application for storing, analyzing and visualizing the data becomes a very convenient way for the decision makers in the organization.

Microsoft Excel is a widely used application due to the simple yet powerful charting techniques. The advanced techniques of Microsoft Excel 2016 fulfills all the requirements of the user by providing new concepts of charts. It supports both, static and interactive types of visualization. While static charts merely display the information, the interactive charts further allows to edit. [1]

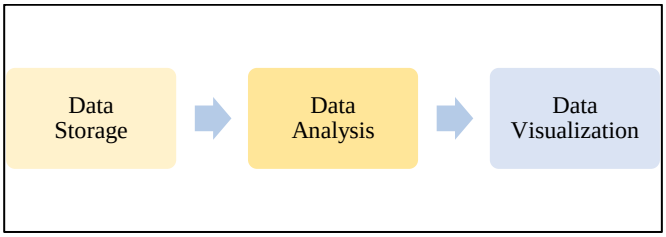

Figure 1. Stages of Big Data

A. Big Data

The advancement in the technology allows the user to capture the data at a very high pace. The outcome is the concept of Big Data. Big data features high volume of data, variety, veracity and velocity. [6] Due to these new features of Big Data, conventional data analysis and visualization tools may not be adequate to get the desired results. The entire process of big data analysis comprises collection, storage, analysis and visualization of the big data. [2] Analysis of Big Data is becoming challenging due to its increased complexity. [7]

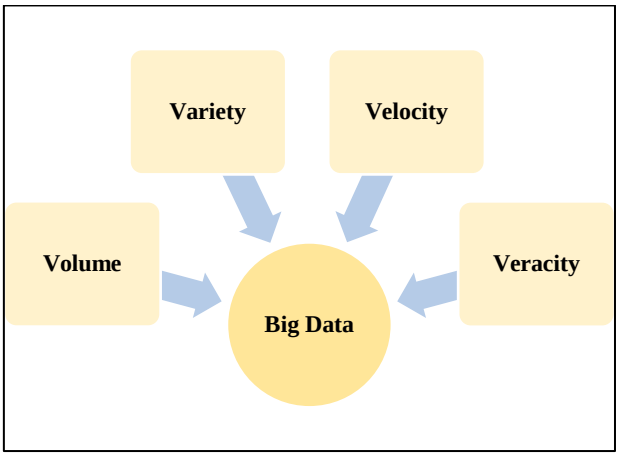

Figure 2. Features of Big Data

B. Microsoft Excel

A Microsoft Excel workbook contain multiple worksheets which allow the user to store the data in a precise format having rows and columns. Numerous formulae are provided that give robust support to analyze the data in different dimensions. In addition to the storage and analysis, further, this application has the capability to present the data graphically using charts of various design. Although, the purpose of all these charts remain same, that is, converting the complex data into more understandable data, all these charts differ from each other in terms of design, logic, elements and pattern of chart. Microsoft Excel allows the user to create interactive charts with graphical user interface. Hence, selecting the appropriate tool and accurate chart type which will be suitable for the specific data becomes most vital. [1]

Microsoft Excel 2016 has all the features of the previous version in addition to modern charting techniques making it a great choice for all types of organizations. Microsoft Excel 2016 with an Office 365 subscription has added six new chart types Box and Whisker chart, Funnel chart, Histogram chart, Sunburst chart, Treemap chart and Waterfall chart. Conventional types of charts like Column charts, Line charts, Pie and Doughnut charts, Bar charts, Area charts, XY Scatter and Bubble charts, Stock charts, Surface charts and Radar charts with their respective subtypes have been used pervasively to present the information. Excel 2016 is compatible with Windows 10, Windows 8.1 and Windows 7. A technical requirement of Graphics hardware acceleration needs a DirectX 10 graphics card. MS Excel 2016 is an integration of new charting techniques and all the charts in the previous version.

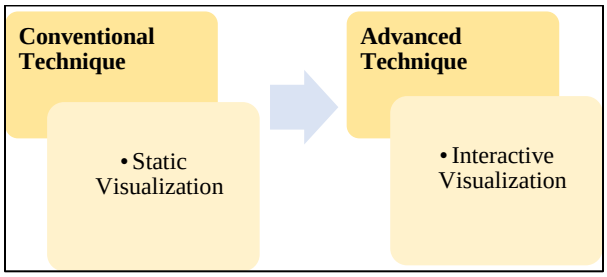

Figure 3. A Voyage from Conventional to Advanced Visualization Techniques with Microsoft Excel 2016

C. Visualization

Conventional visualization approaches such as 'Static Visualization' may not be adequate for the contemporary data and varied data formats. [1] New data types have generated the need of new visualization strategies and approaches. The emphasis should be given on having coherent visualization strategies as the convolution of data is increasing rapidly. [2] Authoritative visualization policies are vital for extracting precise information from the data as **t**he decision makers rely on the information presented by the visualization tool for the data driven decisions. Hence, precise information presented should be in the smart format.

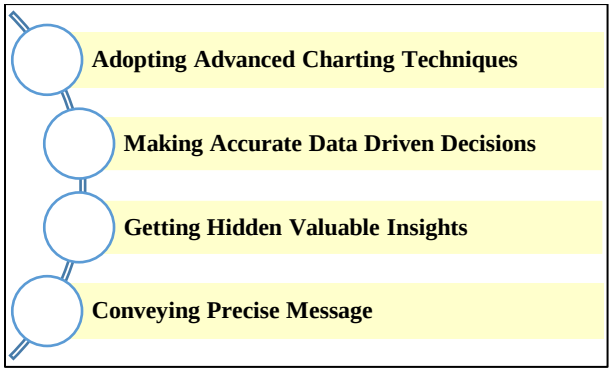

Figure 4. Significance of Selecting the Appropriate Visualization Tool

The purpose of carrying out this study is to demonstrate how the six new chart types in Microsoft Excel 2016 can be applied on the precise data types in engineering manufacturing industries, which they often deal with so as This research gives insight to how to enhance the visualization abilities and upgrade the visualization tool and technique to enhance their data driven decision making.

The pattern of the paper incorporates, Section I contains the introduction of concept of Visualization and charting techniques of Microsoft Excel 2016. Section II encompass the related work describing the significance of visualization in enhancing business decisions. Section III conveys the research methodology. Section IV contains the varied data types in the engineering manufacturing industries. Section V

comprise the advanced charting techniques in MS Excel 2016, Section VI presents Features, Advantages and Disadvantages of using charting techniques in MS Excel 2016, Section VII explain the results and discussion, Section VIII describes conclusion and future scope.

II. Related Work

The difference between traditional static visualization and advanced interactive visualization was studied in the research paper titled, "Comparative Study of Static and Interactive Visualization Approaches" which aims at describing static and interactive visualization approaches considering various factors such as components, uses, role of the user, merits and demerits of both. [1] In another research paper titled, "Significance of Digital Data Visualization Tools in Big Data Analysis for Business Decisions", the authors have discussed the role and importance of visualization of data in the various types of data driven business decisions. [2]

III. RESEARCH METHODOLOGY

An online survey was conducted to discover the current trends of visualization tools and technology that are in practice in the engineering manufacturing industries in Pune. Google Form was used to collect and analyze the data. The purpose of this survey was also to understand the current visualization requirements of the managers at different levels in the organisation. The literature review enabled to discover the existing visualization tools and technologies that are suitable for diverse data types in this industry.

IV. VARIED DATA TYPES IN ENGINEERING MANUFACTURING INDUSTRIES

Data having cyclical format such as daily data or monthly data over a weekly timeframe or over a yearly time frame respectively may need different type of visualization format. Data such as customer feedbacks over a geographical location such as region, city or state wise may be visualized differently.

A. Qualitative Data

Qualitative data integrates all non-numeric data including text, images, audio and video files. The source of this data includes company documents, websites, audio recordings of meetings and video conferecing evidences.

1) *Nominal Data:* Nominal data describes categories but does not have a specific sequence between the categories. The data may be presented with a number. However arithmetic calculations cannot be performed on this data. The data analysis that can be performed on nominal data is frequencies. For example: Product colour: Golden or Silver.

2) *Ordinal Data:* Ordinal data has a specific sequence. For example: Product Feedback: Average, Good and Excellent. Product Status: raw, in process, completed, despatched.

B. Quantitative Data:

Quantitative data is the numeric data. The purpose of quantitative data analysis is to determine the hidden pattersns and to draw the colclusions. Quantitative data analysis can be done with tables, charts or graphs. This analysis is essential for the purpose of certain type of decision making.

1) *Discrete Data:* Discrete data is numeric data in integer format. Typically, it is a count. For example: Number of products manufactured per day, Number of suppliers associated with the company.

2) *Continuous Data:* Continuous data can have any value within the given range. This type of data depicts measurements. For example: Weight of the product, width of the product.

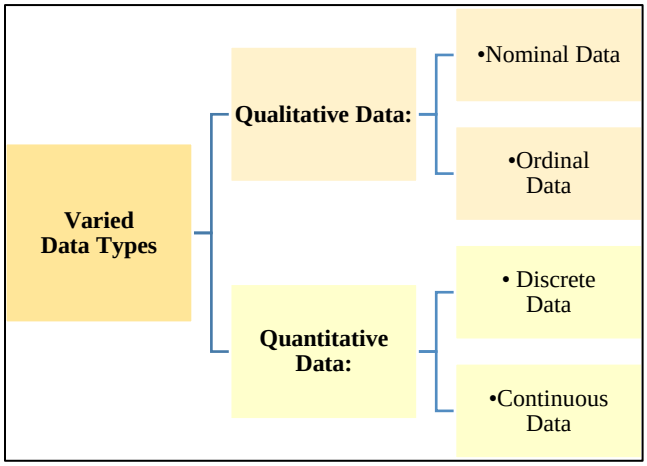

Figure 5. Varied Data Types in Engineering Manufacturing Industries

Classification of the data based on their different formats may include structured data that has a precise format, which is stored in table or worksheet format. Semi-structured data may have a combination of structured and unstructured data making it an assorted format. Unstructured data may integrate text, numbers, audio and video files does not have any specific format and may be in human natural language.

Structured data is much easier to understand, convenient to analyse and most suitable to visualize as compared to semi-structured or unstructured data.

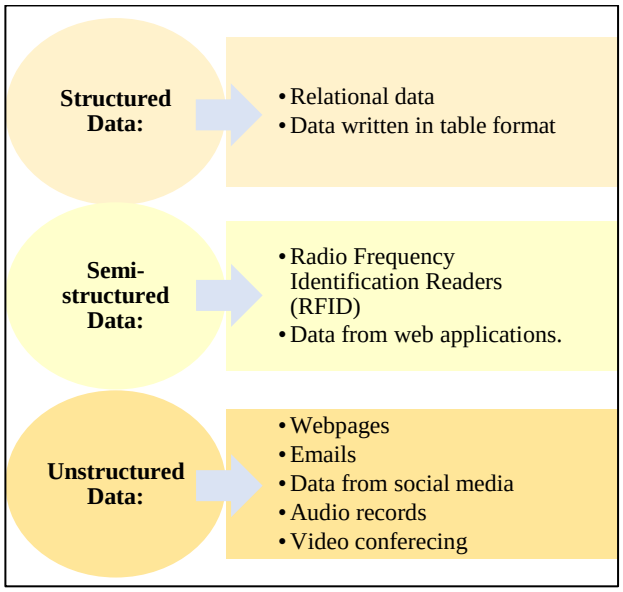

Figure 6. Classification of the data based on their different structural formats

V. ADVANCED CHARTING TECHNIQUES IN MICROSOFT EXCEL 2016

An integrated environment of Microsoft Excel supports data storage, data analysis and data visualization, making it the most appropriate, robust and convenient tool for the managers at all the levels in the manufacturing industries. MS Excel is being used by the managers in the manufacturing industries for multiple purposes. Decision makes in the management depend on the data analysis reports and charts presented by MS Excel for numerous types of data driven decisions.

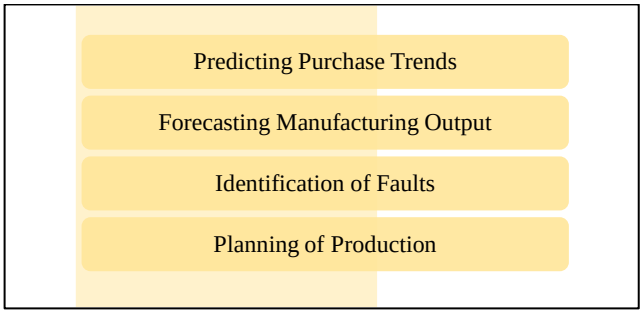

Figure 7. Key Data Driven Business Decisions

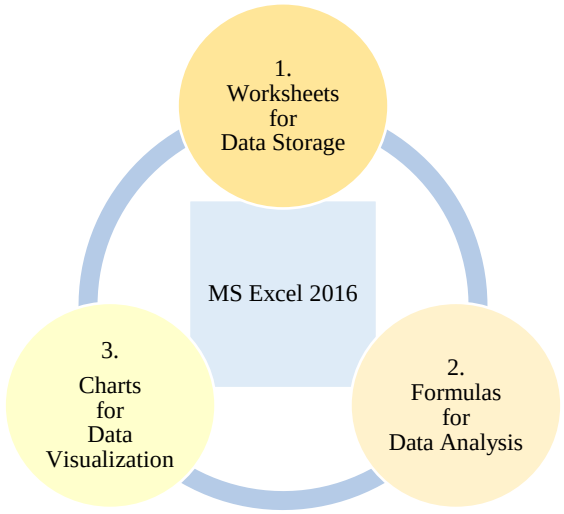

Figure 8. Integrated Environment of Microsoft Excel

The charting technology supports both, data exploration and data presentation. While data exploration means getting new insights from the dataset, data presentation means presenting data graphically.

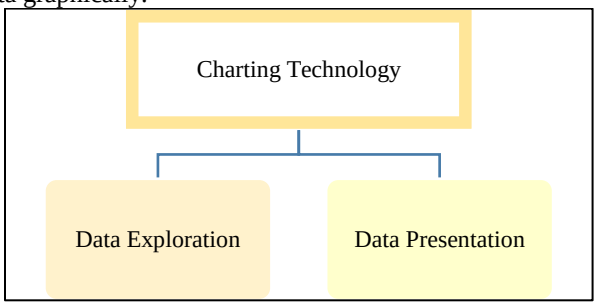

Figure 9. Dual Support Provided by Charting Technology

The charts can be created for the numeric data written in the worksheet. These numbers may be directly entered or derived as a result of formula. [3]

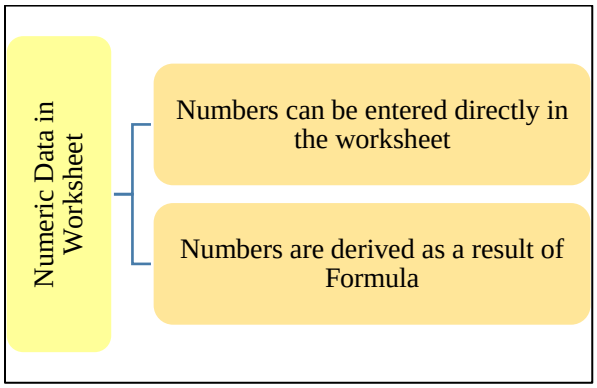

Figure 10. Source of Numeric Data in the Worksheet

Following steps will help to view all the charts, both, old and new in MS Excel 2016: Put the cursor in a cell that contains

data. Select Insert Tab. Select Recommended Charts. Select All Charts Tab. The consolidated list of all the chart types gets displayed.

Features of charting techniques of Microsoft Excel 2016 include 'Recommended Charts' button which helps the user to choose the most suitable chart for the specified data by clicking this button. 'Quick Analysis' button allows the user to add charts to the workbook. Sparklines are little tiny graphs having diverse styles. Combo Chart are two or more types of charts that can be combined in a Combo type. However, 2-D and a 3-D chart types cannot be combined.

Following steps will help the user to view the consolidated list of all the chart types, both, old and new so as to select the anticipated one. First, select the data in cells, then, select 'Insert Tab', Click on 'Recommended Charts', further, select 'All Charts Tab', finally, select the appropriate Chart Type suitable to the data and visualization requirement. [4]

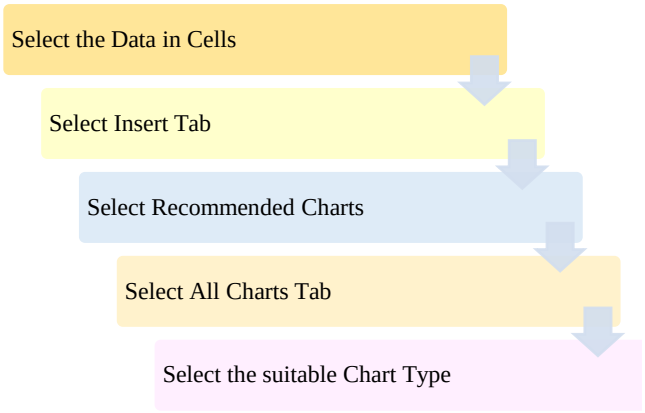

Figure 11. Process of Creating Charts in Microsoft Excel 2016

The Microsoft Excel 2016 integrates both, conventional and advanced chart types. Each chart type present the data in different format making the chart design different from each other. Although, selecting the chart type may entirely depend upon the user, if some factors are considered while choosing the chart type, the charting technique using MS Excel 2016 will give utmost results.

A. Factors to be considered before selecting the chart type:

- Purpose of data visualization.
- The target audience to whom the graphic is to be presented.
- The data type to be visualized.
- The desired outcome of the visualization.
- The most suitable and appropriate chart that would present the information in a simple way and easy to understand.

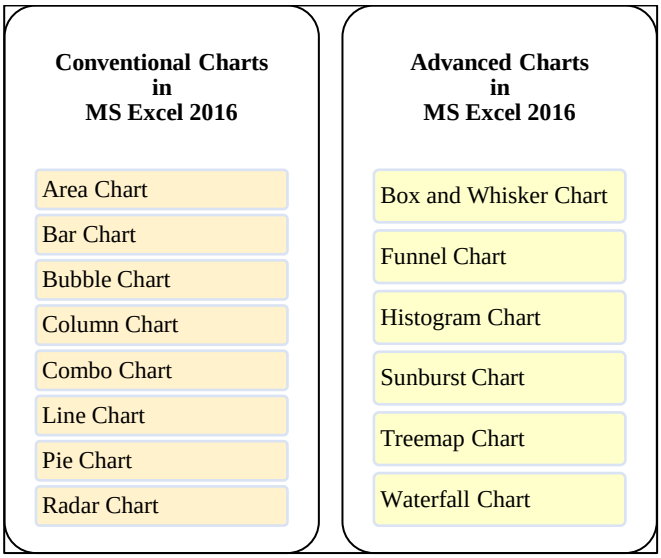

Figure 12. Conventional and Advanced Charts in MS Excel 2016

A. Box and Whisker Chart

A box & whisker chart demonstrations a distribution, highlighting the range, quartiles, mean and outliers. [4] This chart is used for displaying results of statistical analysis. Both, single data series or multiple data series may be selected for creating these charts. For example: Marks of students for multiple subjects, prices of various food items in restaurants. It compares different data sets and shows frequencies within a data set but allows a deeper analysis than a histogram chart. The data is distributed into upper and lower quartiles. The lines that extend vertically are called whiskers. The point which is outside of the lines or whiskers is called as Outlier.

Table 1. Elements of Box and Whisker Chart

Elements	**Attributes of Elements**			
	Attribute 1	***Attribute 2***	***Attribute 3***	***Attribute 4***
Axes	Primary Horizontal	Primary Vertical	-	-
Axis Titles	Primary Horizontal	Primary Vertical	-	-
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	Center	Inside end	Inside base	Outside end
Gridlines	Primary Major Horizontal	Primary Major Vertical	Primary Minor Horizontal	Primary Minor Vertical
Legend	Right	Top	Left	Bottom

Table 2. Illustration Data for Creating Box and Whisker Chart

Product Description	**Product Price Analysis**			
	Supplier A	***Supplier B***	***Supplier C***	***Supplier D***
Housing	450	540	400	630
Bushing	486	513	585	432
Piston	360	432	504	315

Product Description	Product Price Analysis			
	Supplier A	*Supplier B*	*Supplier C*	*Supplier D*
Check Valve	522	387	423	513

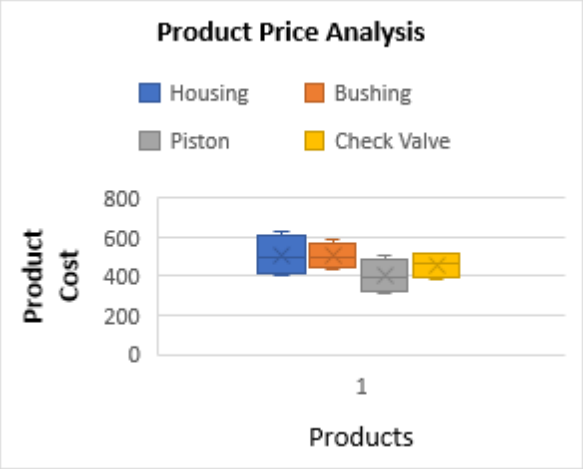

Figure 13. Box and Whisker Chart Presenting Product Price Analysis

B. Funnel Chart

Funnel chart show the stages in a process such as stages in sales process, stages in purchase process etc. The values in the Funnel chart decrease step by step, and thus the bars resemble to a funnel.

Table 3. Elements of Funnel Chart

Elements	Attributes of Elements			
	Attribute 1	*Attribute 2*	*Attribute 3*	*Attribute 4*
Axes	Primary Vertical	-	-	-
Axis Titles	Primary Vertical	-	-	-
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	Center	-	-	-
Legend	Right	Top	Left	Bottom

Table 4. Illustration Data for Creating Funnel Chart

Stages	Vendor Development Process
	Values
Search of potential suppliers	90
Receiving quotations from potential suppliers	63
Evaluation of shortlisted quotations	54
Negotiations and finalisation of terms and conditions	45
Selection and approval of supplier	36
Supplier registration	27

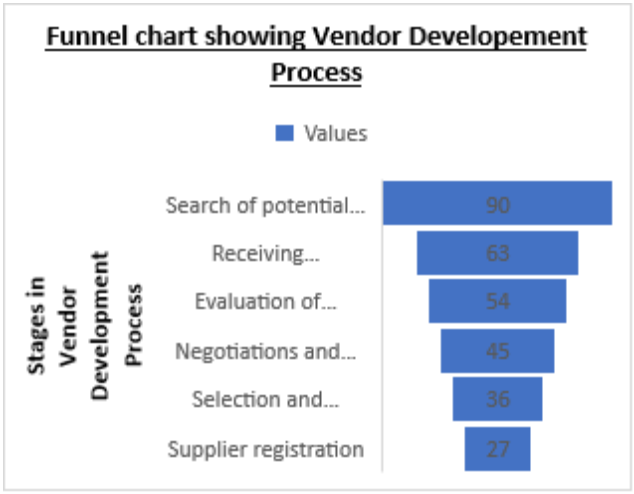

Figure 14. Funnel Chart Presenting Vendor Development Process

C. Histogram Chart

A histogram chart is used in statistics, which displays the frequencies within a distribution. [4] Histogram chart is a column chart used for showing the frequency distribution of quantitative data. However, this chart displays frequencies within only one data set. For creating a histogram two types of data are essential; the data to be analysed and the bin numbers as the intervals by which the frequency is measured. This chart may be used when the statistical data is to be analysed. The vertical axis is a Frequency scale which starts at zero. The horizontal axis is a Data Set having regular intervals. Each bar shows frequency for the respective class.

Table 5. Elements of Histogram Chart

Elements	Attributes of Elements			
	Attribute 1	*Attribute 2*	*Attribute 3*	*Attribute 4*
Axes	Horizontal	Vertical	-	-
Axis Titles	Horizontal	Vertical	-	-
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	Center	Inside End	Inside Base	Outside End
Gridlines	Primary Major Horizontal	Primary Major Vertical	Primary Minor Horizontal	Primary Minor Vertical

Table 6. Illustration Data for Creating Histogram Chart

Cost of Production Material	
Bin	**Frequency**
01-50	36
51-100	45
101-150	18
151-200	27

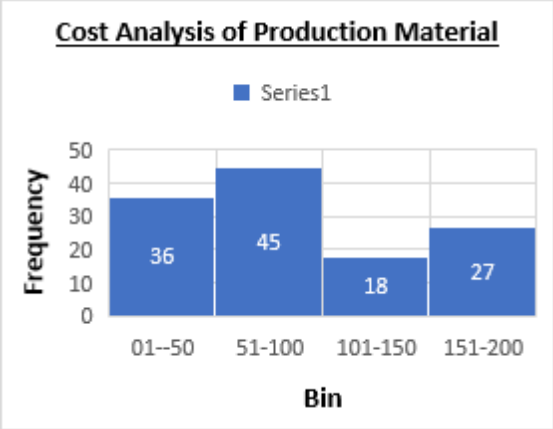

Figure 15. Histogram Chart Showing Cost Analysis of Production Material

D. Sunburst Chart

A sunburst chart presents the full hierarchy of groups, thus, making it is easy to spot the largest contributing segments. [4] Sunburst chart demonstrations hierarchies and relationships. This chart presents hierarchical data in a multi-level pie chart. It is used to display the associates between the groups and their respective sub-groups. A Sunburst chart allows understanding the relationships among the categories and subcategories. Sunburst chart may have one level category or multiple levels of categories. This chart is recommended for showing the hierarchical data. The levels of hierarchies are shown with the help of circles, where innermost circle is the top of the hierarchy. There are no sub-types of chart for sunburst charts.

However, a sunburst chart may have multiple levels of categories where it shows how the outer rings are related to the inner rings. Each ring may be further sub-divided into its respective sub-category. For example: 1 month (one ring) may be further sub-divided into 4 weeks.

Table 7. Elements of Sunburst Chart

Elements	**Attributes of Elements**			
	Attribute 1	***Attribute 2***	***Attribute 3***	***Attribute 4***
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	None	Show	-	-
Legend	Right	Top	Left	Bottom

Table 8. Illustration Data for Creating Sunburst Chart

Production Details			
Quarter	**Month**	**Week**	**Production**
Q1	January	W1	72
		W2	63
		W3	81
		W4	75
	February	W1	81
		W2	54
		W3	45
		W4	54
	March	W1	75
		W2	72
		W3	81
		W4	75
Q2	April		126
	May		207
	June		270
Q3	July		189
	August		171
	September		180
Q4	October		252
	November		243
	December		108

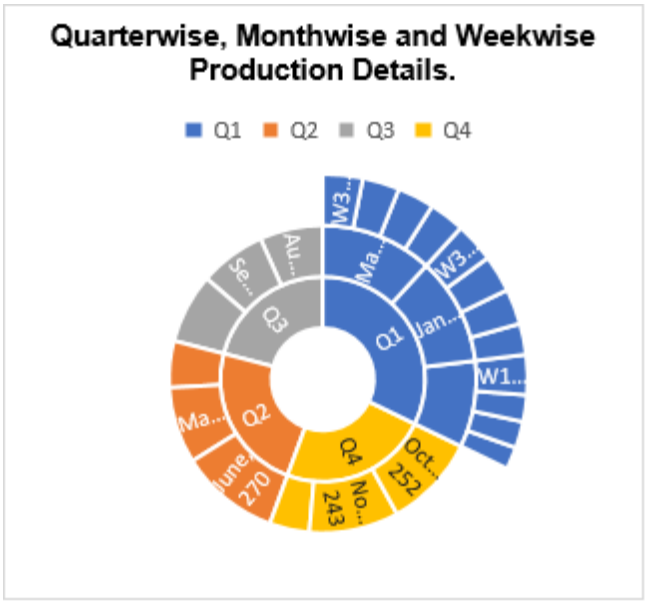

Figure 16. Sunburst Chart Showing Production Details

E. Treemap Chart

Treemap chart provides a hierarchical view of the data and compares the categories. [4] Treemap chart shows hierarchies. This chart gives a hierarchical view of the data in the form of rectangles. The applications of this type of chart are exploring sales per area, inventory per branch etc. Treemap chart creates the visualization of the data in the hierarchical format. This chart allows comparing top level categories and subcategories at a glance. Tree branches are shown in the form of rectangles

where main branches are shown with large sized rectangles and sub branches are shown with smaller sized rectangles. A Treemap chart allows understanding the sizes of categories and subcategories. There are no sub-type charts for Treemap charts. This type of chart is applicable for the data having categories and sub categories such as sales per area, inventory per branch and percentage per area.

Table 9. Elements of Treemap Chart

Elements	Attributes of Elements			
	Attribute 1	***Attribute 2***	***Attribute 3***	***Attribute 4***
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	None	Show	-	-
Legend	Right	Top	Left	Bottom

Table 10. Illustration Data for Creating Treemap Chart

Daily Purchases of Commodity		
Commodity Type	**Commodity Name**	**Price per Commodity (INR)**
Production Material	Castings	300
Production Material	Springs	30
Production Material	Machining Parts	100
Production Material	Fasteners	10
Production Material	Imports	100
Non-Production Material	Tools such as drill	50
Non-Production Material	Consumables such as oil, coolant	200
Non-Production Material	Assembly Tools	150
Non-Production Material	Packing Material	50

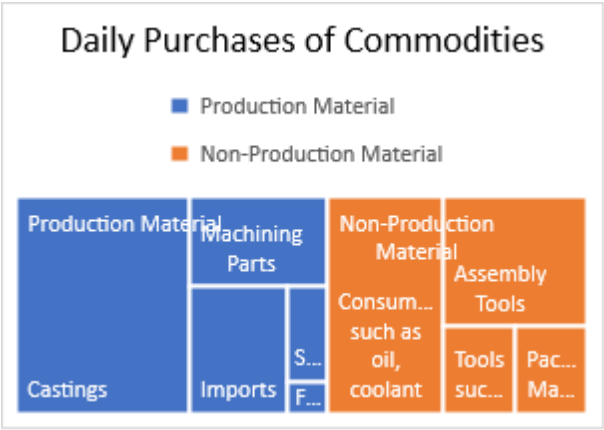

Figure 17. Treemap Chart showing Daily Purchases of Commodities

F. Waterfall Chart

A waterfall chart demonstrates the line items in the data. A waterfall chart shows the running total as values are added or subtracted to the data. [4] Waterfall chart delivers the running total of positive and negative contributions. This chart is used to show the impact of positive and negative values on the total value. The initial and the final value columns start on the horizontal axis. The intermediate values are floating columns. Waterfall chart is also known as Bridge chart. Waterfall charts are suitable for different types of analysis such as analysis of profit and loss, inventory analysis, sales analysis, predicting future trends and budget verses actual comparisons. In the example given below, Waterfall chart clearly states a journey between the prediction of net profit and actual net profit gained.

Table 11. Elements of Waterfall Chart

Elements	Attributes of Elements			
	Attribute 1	***Attribute 2***	***Attribute 3***	***Attribute 4***
Axes	Primary Horizontal	Primary Vertical	-	-
Axis Titles	Primary Horizontal	Primary Vertical	-	-
Chart Title	Above Chart	Centered Overlay	-	-
Data Labels	Center	Inside End	Inside Base	Outside End
Gridlines	Primary Major Horizontal	Primary Major Vertical	Primary Minor Horizontal	Primary Minor Vertical
Legend	Right	Top	Left	Bottom

Table 12. Illustration Data for Creating Waterfall Chart

Net Profit for August 2017: Forecast vs Actual	
Costs	**Amount (INR)**
Forecast of Net Profit	90000
Increase in Raw Material Prices	-9000
Loss of orders from 2 Customers	-18000
Income from 1 New Customer	4500
Reduction in Production Cost	2700
Increase in Transportation Cost	-1800
Actual Net Profit Gained	68400

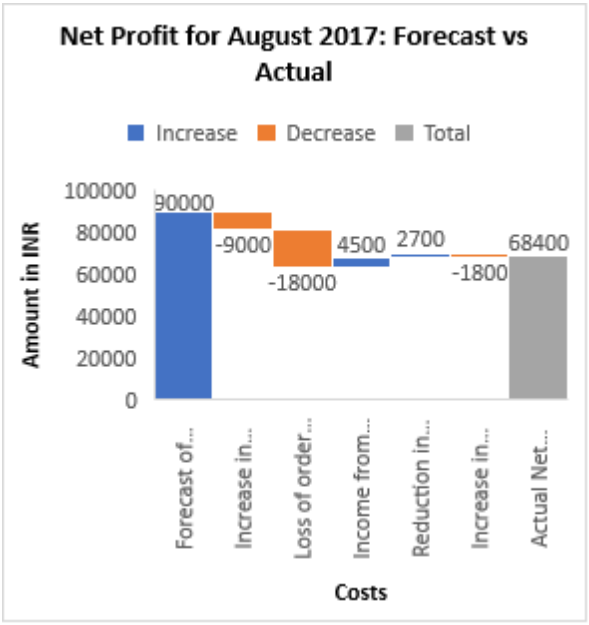

Figure 18. Waterfall Chart Showing Comparison of Net Profit: Forecast vs Actual

VI. FEATURES, ADVANTAGES AND DISADVANTAGES OF USING CHARTS IN MICROSOFT EXCEL 2016

MS Excel 2016 is a very appropriate visualization tool for the managers of engineering manufacturing industries. The charts are easy to create and need less training. Such charts are helpful in data driven decisions. An interactive chart allows the user to edit various factors that affect the contents displayed in the chart [3].

A. Features of Charting Techniques in MS Excel 2016:

- The values entered in the worksheet are robustly linked to the chart so that, if an alteration is made to one or more of the values in the worksheet, MS Excel automatically updates the part of the chart accordingly. [5]
- Editing of charts is allowed including Chart elements such as Chart Title, Data Labels along with Chart Layouts, Chart Styles, Chart Type and the Data in Charts. [5]
- 'Recommended Charts' button which supports the user to select the most suitable chart for the precise data. [5]
- Charts can be created using the 'Quick Analysis Tool'. [5]
- The charts can be created for 1Dimensional, 2Dimensional and 3Dimensional Data. [5]
- Missing data is calculated by using data on either side of the missing points in Line Chart, Area Chart and XY Chart. [3]
- Identification of Maximum and Minimum values can be done by adding two additional data series in the worksheet. [3]
- 'Timeline' type of chart can be created for presenting relatively lesser text. [3]

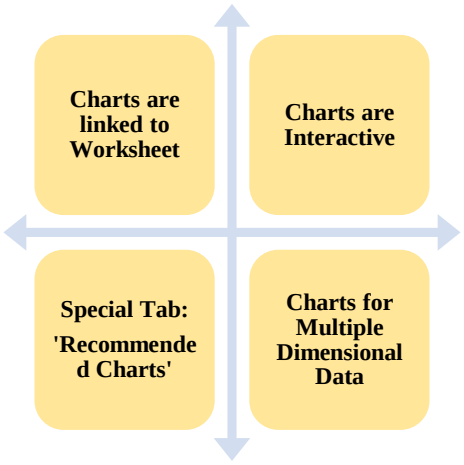

Figure 19. Features of Charts in Microsoft Excel 2016

B. Advantages of using MS Excel 2016 as a Visualization Tool:

- Charts in MS Excel 2016 are simple to develop and understand.
- The charts can be created by the user with no or less training.
- Interactive charts can be created. [3]
- Users of Microsoft Excel 2016 do not require coding knowledge for visualizing the data.
- MS Excel gives a variety of Chart Types to the users, which may be chosen by the user as per the requirement.
- Users get single platform for data storage, data analysis and visualization of data.
- It also allows to import the external data from other databases such as MS Access.
- The design of the charts can be edited with different color schemes.
- The text over the charts can be edited with different font faces and font colors.

C. Disadvantages of using MS Excel 2016 as a Visualization Tool:

- MS Excel 2016 is not an open source tool.
- Enhancing the interaction between the user and the charts may be helpful.

VII. Results and Discussion

Microsoft Excel 2016 is a very powerful tool which integrates data storage, data analysis and data visualization. In addition to the conventional chart types, it also offers new types of charts to visualize the data. Managers in the engineering manufacturing industries may be benefited if they upgrade their system to MS Excel 2016. It is essential because visualisation of data, play a vital role in all the aspects of a business such as accurate decision making, advanced analysis of data, predicting future trends, forecasting customer behaviour and understanding market conditions. Thus, visualization performed with the help of smart visualisation tool may give them enhanced outcome. However, more interactive visualization techniques may support the users of MS Excel 2016 in enhancing the interaction between the charts and the users.

VIII. Conclusion and Future Scope

Due to the varied data types and increasing volume of data, traditional chart types are not sufficient to produce the visualization results to the highest level. There is a need of advanced visualization techniques that will extract the accurate information from the big data. Presenting this extracted information in the smart format is the key challenge for the visualization tool. This paper showcases six such chart types that are applicable for the data types and processes of the engineering manufacturing industries comprising vendor development process, product price analysis, cost of production material, production details, illustrating visualization of the same. Considering the gap between the limitations of conventional chart types and the current visualization requirements, the managers in the engineering manufacturing industries are suggested to select advanced chart types for their visualization requirements. Decision makers should consider the significance of the advanced visualization tools and techniques for getting new insights of the digital data and adopt Microsoft Excel 2016, an integrated environment of data storage, analysis and visualization.

Acknowledgment

We would like to thank the authors of the research papers which were reviewed for writing this research paper and also to the respondents of the survey.

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