



DIAGRAMS, CHARTS AND GRAPHS AS A TOOL FOR PRESENTING PROJECT INFORMATION

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Abstract.

Relevance: In project activities, a large amount of numerical data from different project tasks needs to be handled, which complicates communication between implementers. Adding to the complexity is the significant amount of project information that can be misrepresented and therefore incomprehensible to project implementers. This creates communication barriers until the presenter explains the essence of the process by depicting a diagram, schematic or graph. With this in mind, a graphical presentation of project information, while not replacing textual presentation, is appropriate and greatly accelerates the understanding of the principles of project execution.

Objective: Explore the role of charts, graphs and diagrams as a tool for presenting project information.

Methods: theoretical analysis of scientific sources - to clarify the state of research on this issue in Ukraine and abroad; comparison - to study scientific approaches to solving the problem; synthesis of progressive experience - to present project information in the form of charts, graphs and diagrams.

Results: Gantt chart as a histogram for sequential representation of information is investigated. A flow chart illustrating the progress of any process from general information to project tasks is disclosed. The specifics of the S-curve, both for representing the base or actual cumulative value and for comparing the two over time, are highlighted. The chart columns used to compare and summarize groups of data are analyzed. The characteristics of the resource histogram - for workforce management planning are disclosed. Attention is paid to the trigger diagram used for quality management and reflecting the performance of the profile representation over time.

Particular attention is paid to the Pareto diagram, according to which the analysis of existing problems in project activities and decision-making on quality control are provided. The section of the diagram used to show the contribution of individual elements to the overall project is analyzed. Control chart - to check the stability of any project process both with and without control limits. The main components of the organizational chart are highlighted, which allows to understand the organizational hierarchy, escalation levels and communication path in the project.

Conclusions: the analysis of charts, graphs and schemes as elements of project communication has shown the positive influence of the graphic component on the communication process.

Keywords: *project communication, Gantt chart, block diagram, S curve, bar chart, resource histogram, trigger dia-gram, Pareto diagram, sector diagram, control diagram, organization chart.*

Introduction. The rapid development of society causes the complexity of perception of project information. This is explained by the fact that the individuality of each person is unique, and therefore there are different communication barriers that make it impossible to adequately perceive large amounts of project information.

Therefore, it is relevant to interpret project information through charts, graphs, diagrams and compare

it with other important elements of project communication. Thus, baseline data are fed through a variety of tools to provide perspective and facilitate analysis and decision-making under different circumstances. Some of these tools are used in the process of: planning; execution; monitoring and controlling project tasks. This allows a better perception of the large amount of information through a graphical representation, which in turn is widely used in project activities.

Sources. Scientific and theoretical basis for solving the problem of presenting project information are the works of domestic scientists: V. Radkevich, A. Borodienko, L. Puhovska, A. Samoilenko, A. Radkevich, N. Bazelyuk. The works of foreign researchers deserve special attention: B. Adedeji, C. Baca, P. Jansen, L. Benjamin, B. Dan, J. Shankar.

The article aims. Explore the role of charts, graphs and diagrams as a tool for presenting project information.

Methods: theoretical analysis of scientific sources - to clarify the state of research of the problem in Ukraine and abroad; comparison - to study scientific approaches to solving the problem; synthesis of progressive experience - to interpret the project information in charts, graphs and diagrams.

Results and discussion. Project interaction is impossible without proper communication of pedagogical staff of professional education institutions (hereinafter referred to as project implementers), especially in terms of coordination of their activities (Radkevych, 2021, pp. 132). Thus, communication is an important basis for obtaining information on the implementation of project tasks. It is known that information is transmitted through effective communication, so access to information about project activities reflects the contribution of each participant in its implementation. Communication increases the chances of obtaining reliable information quickly and has a positive impact on the effectiveness of project management and implementation (Borodienko et al., 2020, pp. 166).

In the process of such interaction an innumerable amount of information is generated, which is divided into primary (empirical) and secondary (derivative). Primary (empirical) information is understood as data obtained for the first time to solve a specific problem, not contradicting the methodology of information collection and similar data from other sources. Such information is usually confidential until its public disclosure. Secondary (derived) information is data that can be derived from several sources within a different objective than the purpose for which the data are used. Primary information can arise from secondary information. Often, project activities use both primary and secondary information for consistent analysis and presentation in charts, graphs and diagrams.

With this in mind, we investigated the most impactful types of project information presentation, namely Gantt Chart, Flowchart, S-curve, Resource Histogram, Progress Chart, Pareto Chart, Pie Chart,

Control Chart and Organizational Chart. For example, the Gantt Chart is the most popular tool used to consistently highlight information (especially for human resources). It is a bar chart that illustrates the sequence of project activities and is presented as a graph. There are many tools used for planning and the graph itself can be created in different ways. The key feature of the Gantt chart is that it is easy to perceive, understand and hence create. Note that due to the simple and logical construction of the diagram it is possible to quickly understand the sequence of project activities and to analyse the planning problems of project tasks, which is an important element of internal communication.

The Gantt Chart provides quick answers to the following common questions: when did the project start?; what project activities are envisaged?; what is the order of activities and tasks?; how many project implementers are involved for each type of project task and their names?; how many activities have been completed and their duration, and how many project activities are yet to start? How many project activities have been completed early, late, and which have been postponed?; when is project completion expected? etc.

According to the project needs, the diagram display can be customized to provide only the necessary information. The most popular software application for working with Gantt chart is Microsoft Project (Radkevych, 2019, pp. 129-130). Using Microsoft Project, project managers can analyze the impact of various parameters on the schedule of project activities. The diagram allows to change the allocation of resources among project implementers and view the "floating" information to find out its impact on the overall schedule of project activities. Such analysis helps in decision making by finding alternatives for solving resource conflicts and other project problems. These changes are easily entered into the Gantt Chart to determine their overall effect.

In a Gantt Chart, each task or activity occupies one line. Dates are placed from the top and divided into days, weeks, months or quarters, depending on the overall project duration. The expected time for each task is represented by a horizontal bar, where the left end represents the task start date and the right end represents the expected completion date (Figure 1). These elements of a task constitute the structure of work distribution in the prospectus. Tasks can be performed sequentially, concurrently, or overlapping. So, the Gantt chart can be used to display dependencies (i.e., preference network) between activities. Dependencies provide an indication of the order in which project tasks are performed.

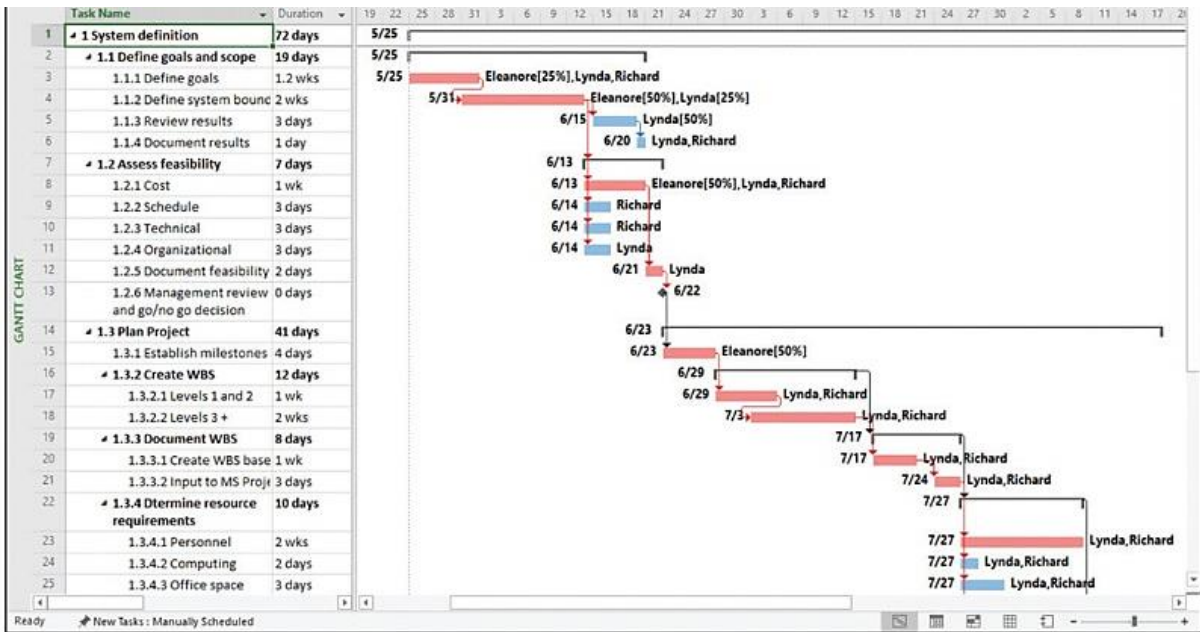


Figure.1 Project Management Hourly Scale

The Gantt Chart can be used in various ways to provide information about various project tasks and their details. First of all, it is project planning (Figure 1), reflecting the timing of the main tasks required to complete the project, as well as the order in which they are completed. Equally important is the project progress measure, it is updated during the execution, monitoring and control, which is further filled in by columns in proportion to the proportion of the work that has been completed (Dan, 2006, pp. 149).

In this context, the differentiation on the construction of project schedules between sequential and parallel planning (execution) is relevant. Parallel

project scheduling involves the simultaneous execution of many project tasks, which saves a large amount of project time, but reduces the quality component of project tasks, which affects the quality of the project. Sequential project planning involves the execution of a single project task by all project implementers, which speeds up its completion and increases the quality component of the project. If you need to model project situations and present the status of project execution as a whole, you should consider the percentage of completed project tasks (Figure 2), which are shaded, and the vertical line "today" to show the status of the current project execution.

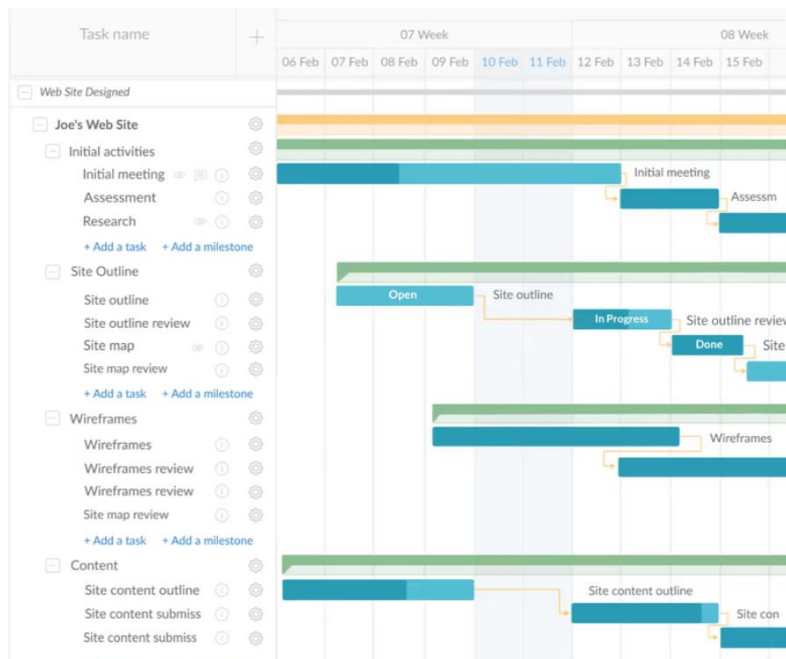


Figure 2. Timing and progress of project tasks

Completed tasks are placed to the left of the "today" line, which shows the status of project tasks: behind schedule if the portion to the left of the "today" line is not completed; ahead of schedule if the completed portion is to the right of the line. Future tasks will be placed to the right of the line. This provides information on what should have been accomplished compared to completed project tasks. This modelling is effective for representing the project schedule and its status to stakeholders. Note that the diagram should reflect the major project

milestones, with a particular focus on key and problem tasks.

While the project is underway, the Gantt Chart allows: first, to track the project on schedule; second, to search for and correct ineffective activities in order to get the project schedule back on track.

Note that 15 to 20 project tasks can fit on one page in a Gantt Chart (Figure 3). For more complex projects, additional charts detailing the timing of all sub-tasks that make up one of the main project tasks may be needed.

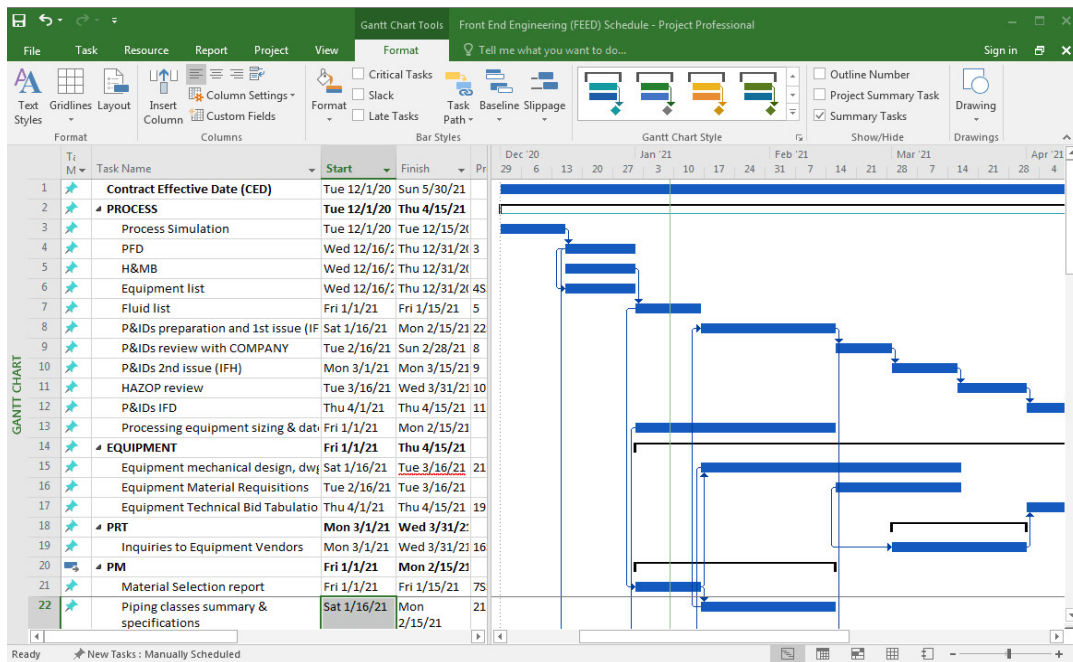


Figure 3. Example of a Gantt Chart

An important type of diagram for presenting project information is a flow chart that illustrates the flow of any process: from general information to project tasks (Figure 4). The tool graphically depicts

the steps that need to be taken to complete a particular task. As part of project communication there is a need to present project information using flowcharts, which is an effective tool for visual presentation.

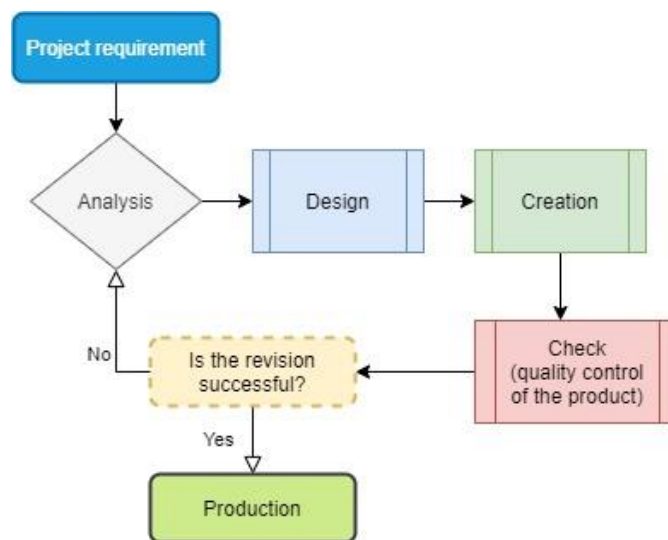


Figure 4. Sample flowchart

The use of flowcharts in a project occurs: first, when it is necessary to explain the steps for performing the task to the project executors; second, when it is necessary to implement the project-architectural approach; third, to present the organizational chart; fourth, to form planning diagrams; fifth, to create logical schemes of situation analysis for solving internal-project problems.

Flowcharts are indispensable at the start of every project when there is a need for a holistic presentation of the project and its objectives - from inception to successful completion. An important element of presenting a project through a flowchart is to discuss

it coherently, which will ensure a common understanding among stakeholders from the beginning and help avoid misunderstandings at the end of the project. Note that the flowchart should demonstrate the current state and what the end result will look like after the project is implemented, so it should contain the main inputs, processes, outputs and present a clear sequence of activities. It can be easily created using Microsoft Visio (Figure 5). Simpler diagrams can be created using Microsoft Word functions. A flowchart can also be created using Smart-Art in Microsoft Word to show the sequence of activities, which is very effective when comparing two or more processes.

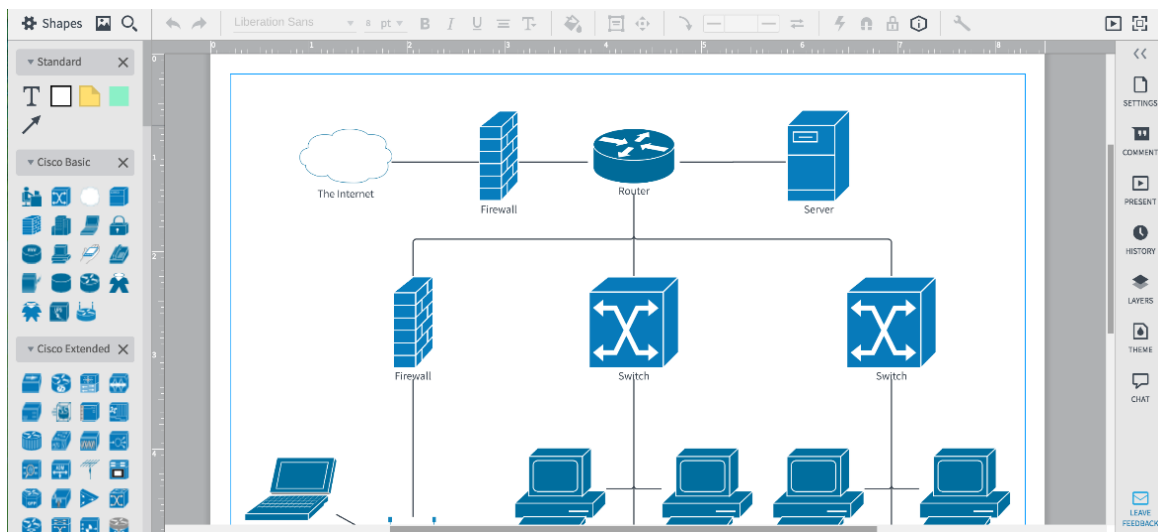


Figure 5. Microsoft Visio

For a holistic understanding of the flowchart, it is important to represent it as a "Swimlane" (Figure 6). The "swimlane" concept refers to the distribution of tasks into tracks belonging to specific project implementers. The tracks can be arranged both horizon-

tally and vertically, only the starting point of the diagram, which is the upper left corner, is unchanged. Note that this type of flowchart will not be effective when executing many projects at the same time, because it creates tangled schedules.

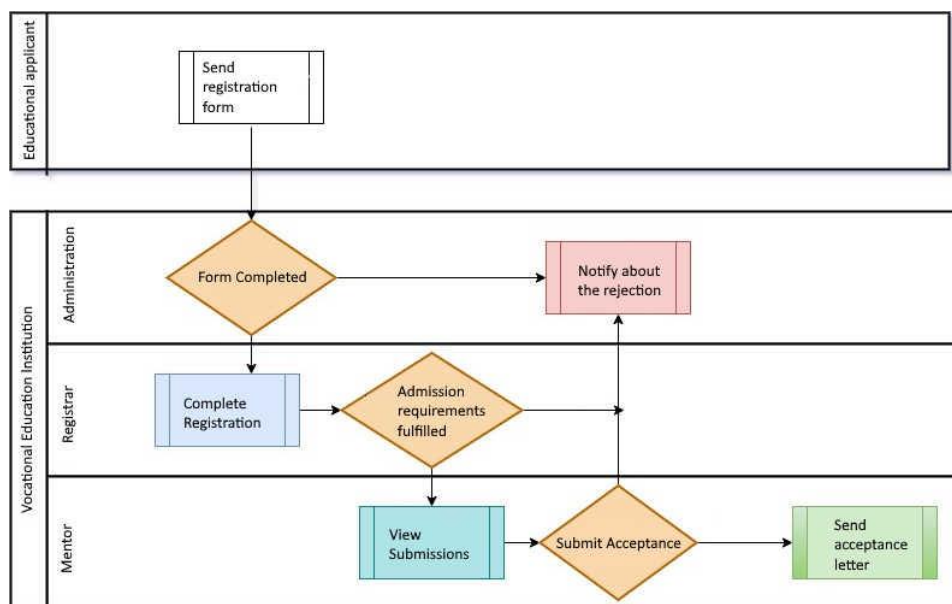


Figure 6. Representation of the block diagram as a Swimlane

Another important element of using flowcharts of "swimming lanes" type is to specify the head of the project task, who can act as an individual or a legal entity. In this case, the flowchart will be cross-functional, i.e., provide for communication between performers of different organizations that perform a common task, which has a positive effect on the analysis and highlights losses, if any. It is the lack of coordination that can cause problems in communication between external and internal project implementers. It also shows who is in control of each part of the process. Sometimes the different phases of the process can be demonstrated through 'swim lanes' and the owner can be identified through a colour code that highlights the compliance lane. In the context outlined, no special knowledge is needed to create flowcharts and then everyone can create and understand it if they wish.

A widely used tool for representing the baseline, actual cumulative project cost, and for comparing the two over time is the S-curve graph. The cumulative values of actual cost, planned cost, funds received, and budget for completing the profile can be demonstrated by plotting a graph over time, where all of its boundaries form an "S" shape. It is equal at the beginning and at the end, and rounded in the middle (Dan, 2006, pp. 153). When these parameters are plotted on a graph with a time component, they represent critical information about project performance, such as: volume, cost (or resources), and schedule. Note that this can also be used for cost variance, funding requirements, and forecasting purposes.

In this context, it is relevant to have software that automatically generates Curve S graphs. Among the software products that support this capability are Microsoft Word, Excel, and Project. These applications can be used to plot cumulative values relative to the time/project phase using a smooth line curve, as shown in Figure 7.

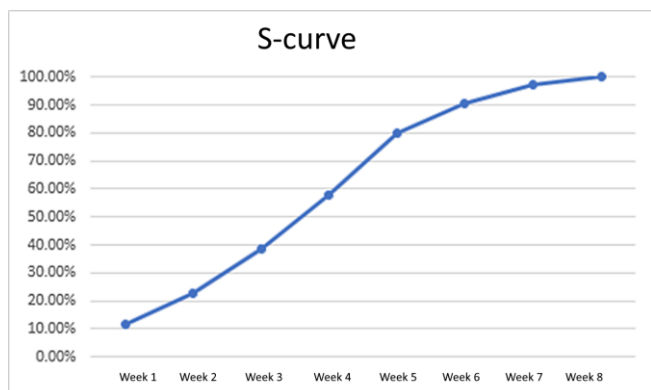


Figure 7. S curve

What deserves attention is the cost baseline, which is the project budget that is determined over time; hence, when the total cost is added up over time, this gives the cost baseline. It is possible to determine the budgeted cost of a project at different points and easily predict the budget (Baca and Jansen, 2003). The diagram in Figure 8 is a simple one that shows the actual cumulative cost compared to the cost baseline.

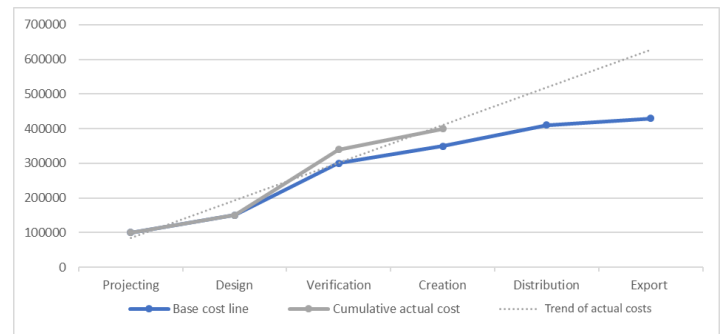


Figure 8. Demonstration of actual costs compared to the baseline

This diagram illustrates the status of the project in terms of cost. The cost baseline represents the total budget for the design, design, quality assurance, build, and other phases. The total cost at the end of the build phase is the combined actual cost of initializing design requirements and the build phase. The chart clearly shows the trend of actual costs, and if the trend continues, the actual cost at the end of the project can be predicted. Note that a simple chart like this can be plotted on a time basis (monthly, quarterly, etc.).

The S curve reflects the rate of cost growth, which is slow in the beginning because the project starts with only a few participants. The design phase usually has very few resources. Over time, the project is staffed with all key team members. The project peaks during the build phase, when the maximum amount of work takes place. Suddenly, the number of human resources and the amount of other important resources needed to complete the project grows. This is where the growth rate peaks and finally levels off as very little change in human resources and capital occurs in the last phase of the project.

A bar chart is used to identify trends and comparisons. When making a chart for comparison, you can use different colours for different subjects. It is also called a bar chart, a special type of bar chart used to summarize groups of data. Project managers monitor the actual cost of the project and need to compare them with the project budget. The budget can be allocated according to the timing of the project, so it

can be compared very effectively on a monthly or quarterly basis. The bar chart is an effective tool for tracking, monitoring and reporting resource data. It is also a useful tool for reporting as it captures a lot of information. Relevant software for creating bar charts and bar graphs is Microsoft Excel, Word. One

variety is an accumulation bar chart, which can be used to represent the contributions of different components at different locations or times (Figure 9). Another example would be a combined chart, where a bar chart can be shown in combination with a line chart, which is actively used in the Pareto diagram.

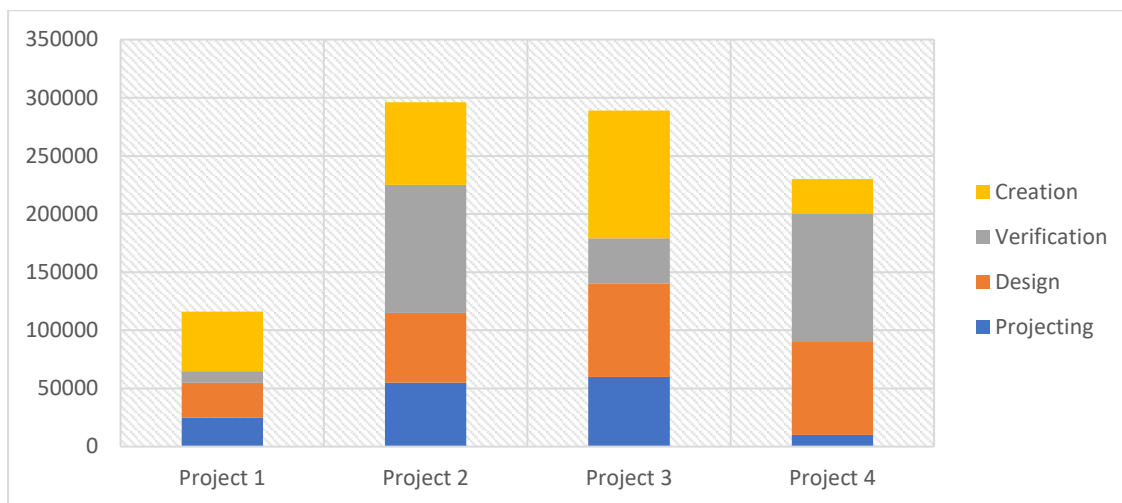


Figure 9. Example of a bar chart with accumulation

The use of coloured accompaniment makes the visual presentation better for perception, as it is easy to understand the differences at a glance. Note that

identical data can be presented in different ways, which makes it easier to perceive (Figure 10).

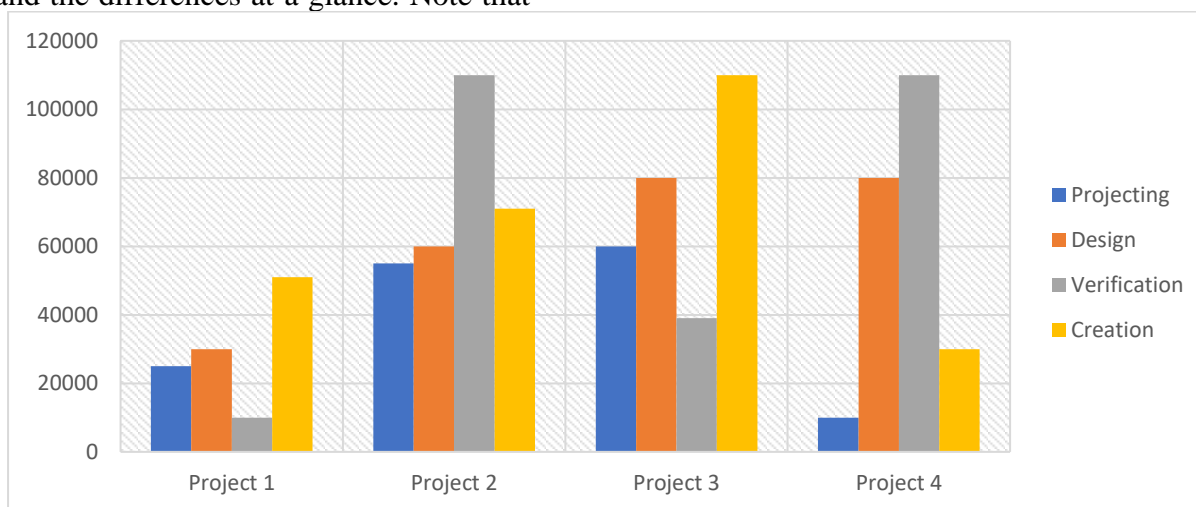


Figure 10. Example of a split indicator chart column

For human resource management planning, where human resources are represented in the form of a bar chart, it is advisable to use a resource bar chart. It illustrates the number of hours that an individual, department, or the entire project team needs to work continuously. This histogram can contain a horizontal line of 100% (Figure 11) that includes the maximum number of hours available for a certain resource. Columns that extend beyond the line indicate the need to level up resources. For example, adding more resources or extending the project schedule or

a specific task.

According to the graph, you can find out the surplus of the remaining resources, its percentage distribution, redistribution, etc. Thus, it is possible to set a different color for redistribution (Fig. 11), which shows the presence of excess resources. Accordingly, Fig. 12 shows the number of over-allocated man-hours for a similar task with the same duration. Note that you can change the parameters in Microsoft Project to get a bar chart with different resource parameters.

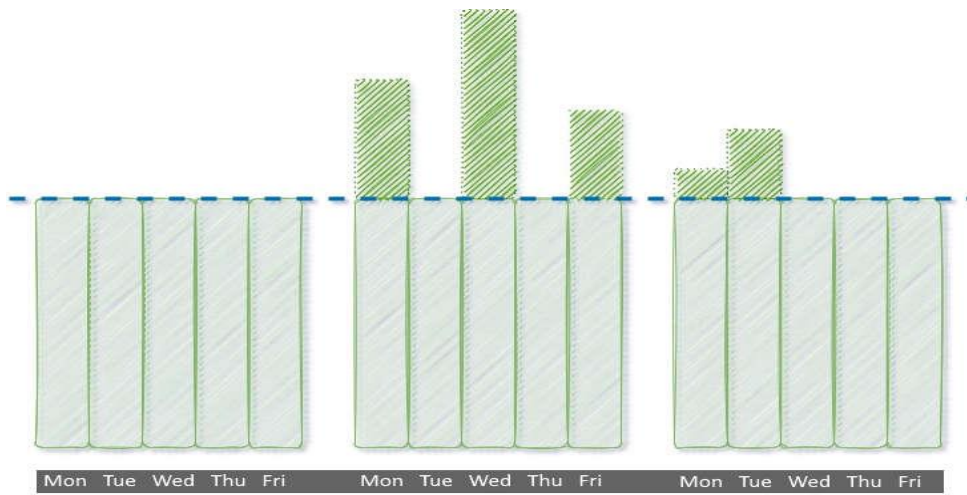


Figure 11. Resource histogram

The use of this tool is actively used in reporting for analysis and decision making. Note that multi-tiered profile managers can use this tool to optimize resource levels, allocate them efficiently and use them optimally. In fact, the powerful visual presentation of the tool facilitates its use and analysis. It is possible to create graphs by weeks or months, allowing you to compare the allocated work time for different resources. Any allocation that exceeds the line

of 160 hours must be corrected with resource alignment. Similarly, an allocation versus utilization can be created for resources and can be analyzed before making adjustments.

A resource bar chart is useful when managers perform resource planning or allocate resources among multiple projects in a program. Resource allocations should be reviewed once a week or every two weeks to ensure that no resource is over- or under-allocated.

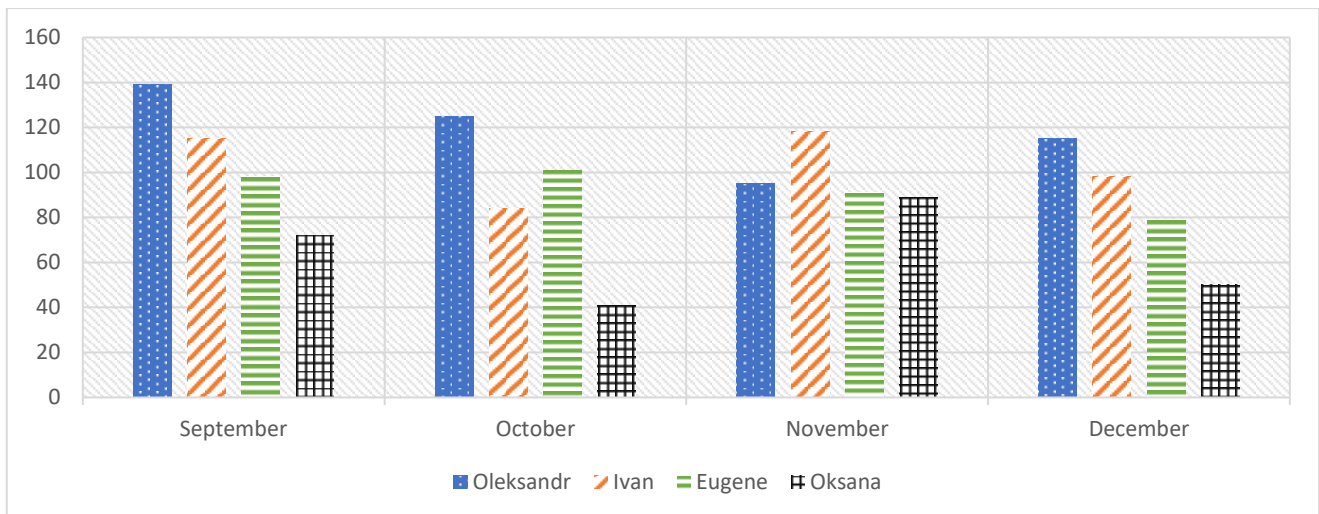


Figure 12. Sample Resource Histogram for Unequal Distribution of Man-Hours

A start-up diagram can be used to manage project quality. It is also called a line or cycle sequence diagram and is used to show process performance over time (Figure 13). Process results or deliverables are plotted in chronological order over time. The data points are plotted over time (days) and connected by a line; they indicate a trend. Increasing or decreasing trends, cycles and large outliers can be detected and investigated further by project managers. When multiple variables are tracked on the same chart across multiple lines, each variable has its own line;

the chart is then called a multiple run chart (Shankar, 2010, sap).

Before interpreting the trigger diagram, it is necessary: firstly, to analyse the actual data over a considerable period of time so that the "normal" range of variation is evident. This demonstrates whether the improvement in the outcome is temporary or systematic; second, whether the recent data are within the normal range of variation; and third, correspondences in daily, weekly, monthly and annual charts should be found.

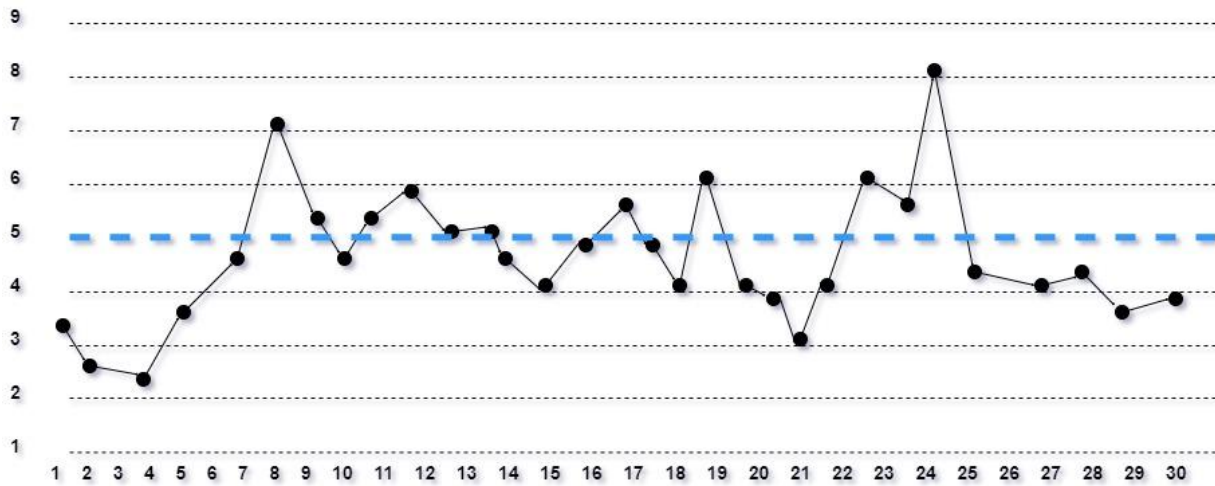


Figure 13. Start-up diagram (line diagram or cycle sequence diagram)

An effective tool for analysing different kinds of problems as well as costs and making decisions is the Pareto diagram. This tool is widely used and easy to understand, and is very common for quality control. A Pareto diagram is used to separate several vital tasks (resources) from trivial ones. It works on the principle that when several factors influence a situation, they account for most of the influence. So, the tool is useful when there are many problems or causes and one wants to focus on the most significant and most dominant ones.

A Pareto diagram arranges data in a way that makes the relative importance of data categories apparent to the user. Only objective data should be used when applying this tool. It is created as a histogram, where the length of the bars represents frequency, cost, time, or money, and are arranged with the longest bars on the left and the shortest on the right. Generally, the left vertical axis represents frequency, cost, or other important indicator, and the right vertical axis represents cumulative frequency, total cost (Baca and Jansen, 2003, pp. 121). The horizontal axis represents categories or groups. Follow the steps below to create the diagram:

- first list all the problems and group them together. After that, specify the categories to be used for grouping.
- identify the relevant dimensions. Common measurements are frequency (how often a problem occurs), quantity (how many performers are needed to complete the job), cost (how many resources are needed) and time (how long it takes);
- define the time period to be covered by the Pareto diagram (e.g.: work cycle, one whole day, week, etc.)
- determine the frequency data for each category or group. Make a subtotal for each group;

- to plot the histogram, determine the appropriate scale. The maximum value will be the largest subtotal. Mark the scale on the left side of the chart;
- draw the columns for each group, then place the group with the highest frequency (the highest bar) at the edge on the left, and then the next highest on the right, and so on. If there are many groups with small dimensions, they can be grouped as "different" or "other" (Shankar, 2010, pp. 103).

By the way, note that the following steps are optional:

- calculate the percentage for each group as the subtotal for that group divided by the total for all categories. Mark the correct vertical axis and label it with the percentages. Ensure that the two scales are congruent; for example, the figure on the left corresponding to half should be the exact opposite (50%) on the scale on the right;
- calculate cumulative sums. Add intermediate totals for the first and second groups and dot above the second bar that indicates this sum. Add the subtotals for the third group to this total and dot the third column of this new total. Continue the process for all columns. Connect the points starting at the top of the first bar. The last point should reach 100% on the desired scale.

Note that after outlining a horizontal line at the 80 percent mark and dropping a vertical line from the point where the horizontal line 80 percent touches the curve, then the categories to the left of the vertical line represent vital factors and those to the right are trivial (Figure 14). This is called the "80/20 rule," meaning that 80 percent of defects or problems are caused by 20 percent of the contributing factors. Consequently, one should focus on the vital 20 percent of the causes.

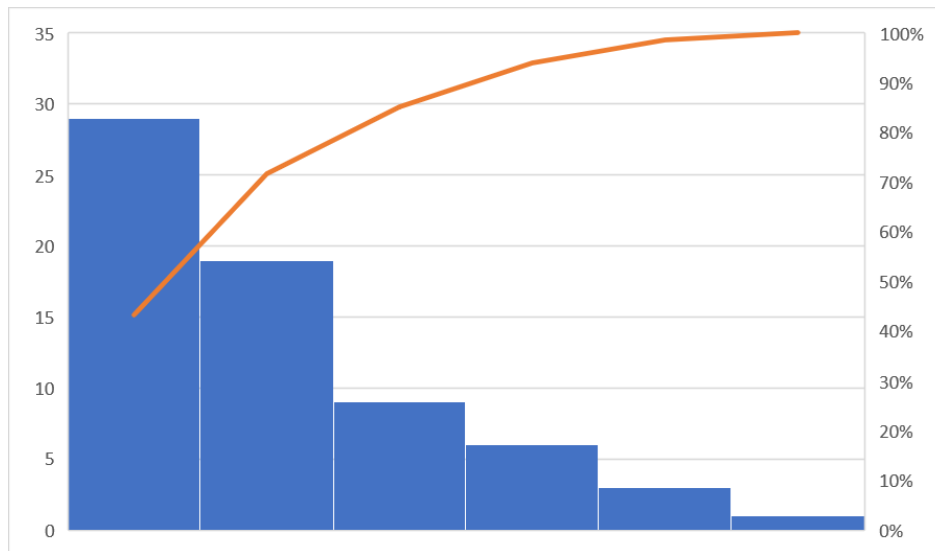


Figure 14. Pareto diagram

There may be many different reasons why defects occur in a project. These should be carefully, appropriately grouped: those that cause few defects are grouped into the 'other' category. The diagram can place the following condition on management or the project team: most defects (80 percent) will be eliminated if the root causes of "unskilled resource" and "oversight" are eliminated. Therefore, rather than developing methods to prevent accidental defects, it is worth focusing on eliminating the more significant causes. There is always a mismatch in the number of issues, resources and budget available for a project. Consequently, to achieve maximum benefit by using time, resources and budget more efficiently, you need to perform this exercise and then properly leverage resources. In doing so, be clear about which group should be targeted first, as sometimes there may be other considerations that are not so obvious to the project manager. Use brainstorming and a cause-and-effect diagram to find the

root cause. When the root cause is known, do the Schuchart-Deming cycle, or PDCA (plan-do-check-act), to fix the problem. Note that the Schuchart-Deming cycle is a continuous process improvement model. It is universal and aims to effectively manage all activities on a project basis (Shankar, 2010, pp. 103).

A pie chart is used to represent the contribution of project implementers. It is circular and looks like a circle divided into many parts from the centre. The circle represents all data, while each slice or sector represents a different class or group as a whole. The length of each arc (in a two-dimensional diagram) or the area of each sector (in a three-dimensional diagram) is equal to the proportion it represents compared to the entire data set (Shankar, 2010, pp. 103). The use of colours provides an improved visual presentation. There is a lot of software for creating pie charts, the most popular being Microsoft Excel, Word (Figure 15).

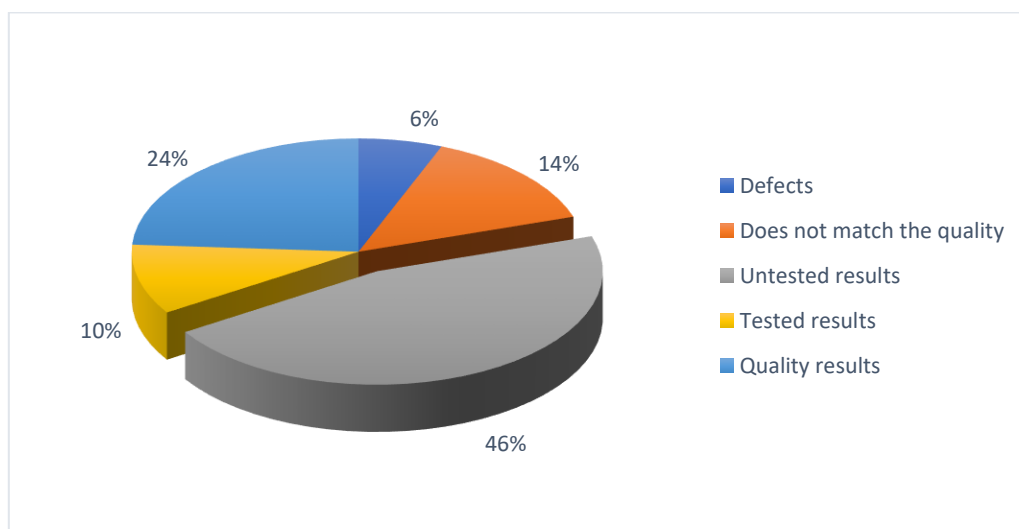


Figure 15. Sector diagram

A diagram in a sector is used when comparing the size of one sector to the size of the whole diagram. It demonstrates the information particularly well if the sectors represent 25-50 percent of the total data. Smaller sectors can be aggregated with each other according to certain criteria. Note that in other cases graphs, bar charts, point charts or a non-graphical method such as tables can be used to present information.

A disadvantage of the pie chart is that it is difficult to read. For example, comparing different sections of a pie chart to each other, or comparing data in different pie charts, can be very difficult. Given this, it is not recommended to use a pie chart in such situations, and a bar chart is more appropriate. How-

ever, it is worth using this chart to demonstrate identified defects or quarterly cost allocation. It can be easily customised by presenting the information through a three-dimensional or two-dimensional chart, and, if necessary, presenting the data as percentages or absolute values. Depending on the need and situation, charts can be modified to make them more suitable and better for visual presentation of information.

A powerful tool for managing statistical processes is the control chart. It is used to check the stability of the process in any activity and to improve it. The project uses many resources for predictability and consistency in the delivery of outputs and outcomes (Figure 16).

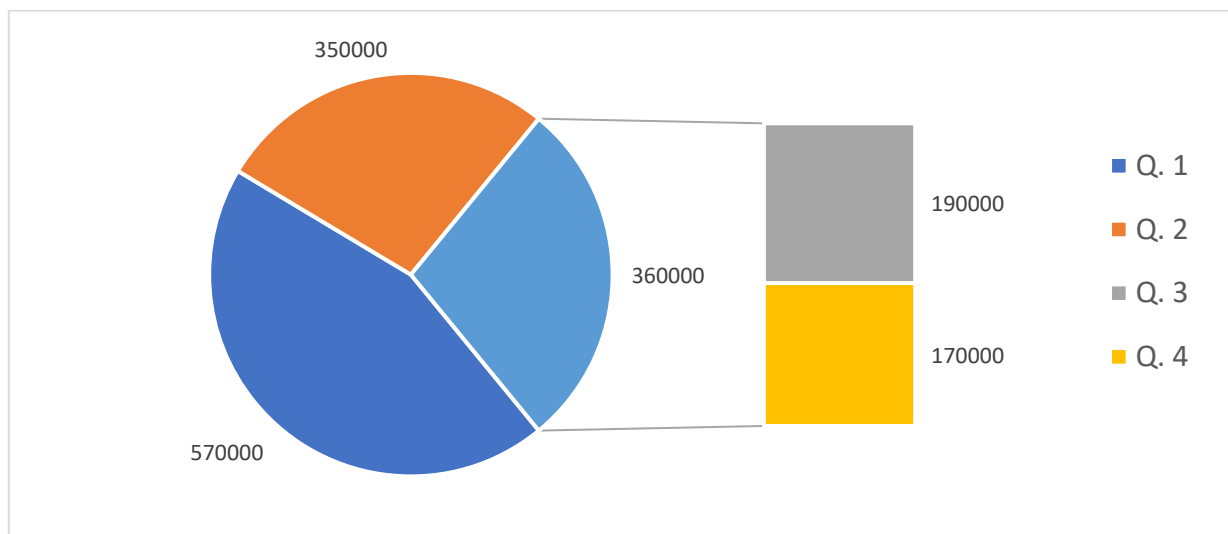


Figure 16. Section diagram

Using an appropriate control chart, results should be continuously monitored to distinguish the specific causes of variation from the general ones and, by examining them, to establish how the process changes over time. Note that several varieties of this tool are used in different situations. Here are the characteristics of a stable task (process): first, all causes that induce variations are known; second, variations are available; third, the process is governed by common causes of variation; fourth, the outcome of the process is largely predictable.

Let us disclose situations in which a control chart should be used: first, controlling ongoing processes by finding and correcting problems as they occur; second, predicting the expected range of process outcomes; third, determining the stability of a process (in statistical control); fifth, analyzing patterns of process change from special causes (irregular events), or common causes (embedded in the process); fifth, establishing the inherent quality improvement (Shankar, 2010, pp. 105).

Therefore, it is important to understand the concept of common and special causes of variation. The common cause, is the variation occurring in the process itself; it cannot be easily eliminated without significant investment. These are variations in output caused by unknown factors and result in a stable but random distribution around the midline in the trigger diagram.

Common cause provides a measure of the potential of a process, in other words, it indicates how well the process would perform in the absence of specific causes of change. It is also known as random variation, noise, uncontrolled variation, intra-group variation and intrinsic variation. Here are some examples of common causes:

- the unsatisfactory condition of the workplace;
- bad design;
- poor quality raw materials;
- inappropriate quality control procedure;
- incompetent workforce;
- variability in the final product settings;

- unqualified maintenance of machinery.

A special cause is a circumstance caused by a particular problem that is unpredictable, new, or previously neglected in the project system. This type of variation is unpredictable and always unexpected. Variations caused by these causes can be easily detected and eliminated. Examples of a special cause are:

- lack of technical skills;
- lack of knowledge;
- lack of appropriate type of infrastructure;
- bad design;
- change in the job (process);
- insufficient resource base;
- computer glitch;
- unplanned vacations of a large number of employees (Shankar, 2010, pp. 105-106).

In the context of the control chart, note that data can be classified into two types:

- variable data. Anything that can be measured is called variable data. They are also called quantitative data. Variable data are measured in quantitative

units and answer the question "how much?" Examples of variable data are variance, percentage of change in a graph, weight, etc;

- attribute data. These are unmeasured data representing their lowest level and are purely binary in nature, which unilaterally answers the question: good or bad; yes or no. Attribute data is qualitative data that needs to be taken into account for accounting and its analysis. This will answer the question "how much". For example, attribute data can include the number of defects, the presence or absence of necessary product information, error correction, acceptance or rejection of decisions, etc.

Here is another type of control chart. Note that it always has a center line for the mean (CEN), an upper line for the upper control limit (UCL) and a lower line for the lower control limit (LCL) (Adedeji, 2008, pp. 98) (Figure 17). By comparing the current data with these lines, it is possible to conclude whether the process variation is consistent (controllable) and or unpredictable (uncontrollable, which occurs under the influence of special causes, changes).

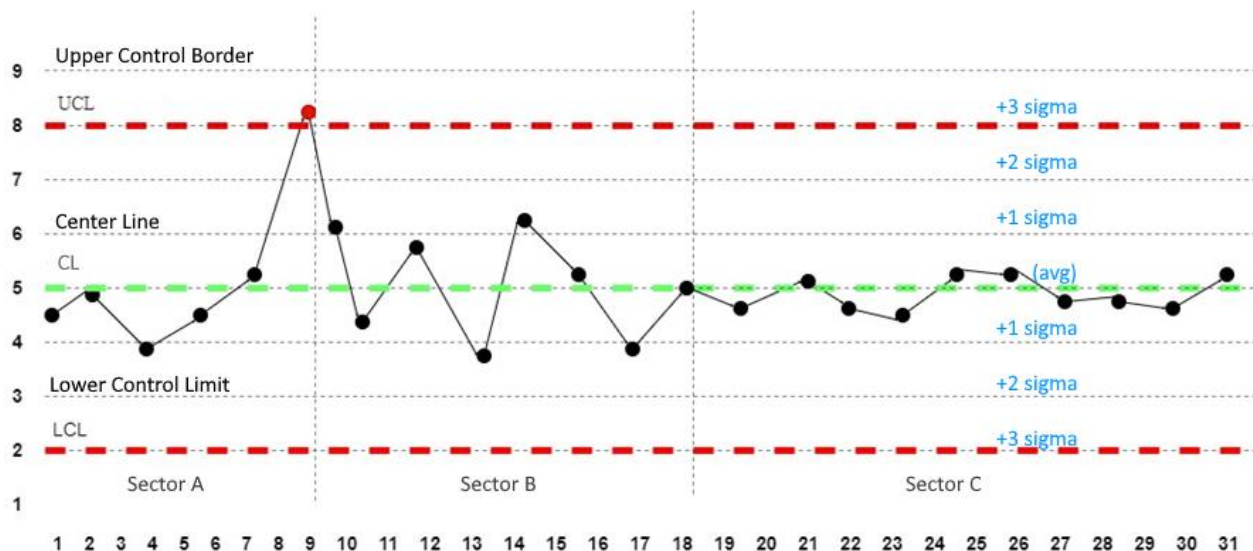


Figure 17. Control chart with center and upper and lower control lines

Variable data control charts are used in pairs. The upper chart tracks the average or centralization of the distribution of data from the process. The lower chart tracks the range or width of the distribution. Attribute data control charts are used as one chart. Different types of control charts are available for both of these data types (Baca and Jansen, 2003, pp. 120).

The control chart in Figure 17 has three sections. "Section A" shows one point outside the UCL. This indicates that there is a source of particular variation and it needs to be analyzed and the cause of the variance determined. The data points outside the control

are noticeable, which asks the search for inconsistencies. Let's pay attention to "section B" of the diagram, all its points lie within the control, hence have only common causes of variance.

In "section B" the trend of the results of project activities is more predictable and runs smoothly. This proves that the process improvement has worked, the process has become stable, and the future performance of the process is predictable. Consequently, eliminating the specific causes of variation will make sustainable control action possible, and process improvement will reduce variation and shift the control boundary towards the process centerline.

Note that the UCL and LCL are not specification boundaries. The control limits are calculated based on process performance, and the specification limits are based on customer or organizational requirements.

Let's pay attention to the dotted lines (Fig. 17) that cross the whole table, these are the control limits that distinguish the control chart from a simple line chart or execution chart. Their main purpose is to help determine the stability of the design problem (process)

Control lines are calculated based on the design data for a particular task.

In a stable process, 68.3% of the data points should be within ± 1 sigma, 95.5% of the data points should be within ± 2 sigma, and 99.7% of the data points should be between UCL and LCL.

To determine the control limits, a center line (CL) equal to the mean or median of the available data must be calculated. The sigma is then calculated using a formula that depends on the type of data and the sigma lines (± 1 sigma, ± 2 sigma, and ± 3 sigma from the center line). Thus, the extreme lines are $+3$ and -3 sigma's, which are at the upper, lower reference limits (Charts, C. and KnowWare International).

The data for sigma can be: continuous or discrete; sampling volume static or dynamic. There is a different sigma formula for each type of data, and therefore a different type of control chart. There are seven basic types of control charts (c, p, u, np, individual variable range graph, XmR, X bar R and X bar S), and many other variations for special cases. Among them, the following formulas for:

p diagram (1)	an individual variable range graph (2)	X bar R diagrams (3)
$UCL = \bar{p} + 3\sqrt{\left(\frac{\bar{p}(1-\bar{p})}{n_i}\right)}$	$UCL = \bar{X} + E_2\bar{R}$	$UCL = \bar{\bar{X}} + A_2\bar{R}$
$CL = \bar{p} = \frac{\sum p_i}{\sum n_i}$	$CL = \bar{X} = \frac{\sum_{i=1,k} X_i}{k}$	$CL = \bar{\bar{X}} = \frac{\sum_{i=1,k} \bar{X}_i}{k}$
$LCL = \bar{p} - 3\sqrt{\left(\frac{\bar{p}(1-\bar{p})}{n_i}\right)}$	$LCL = \bar{X} - E_2\bar{R}$	$LCL = \bar{\bar{X}} - A_2\bar{R}$

A project communication tool that allows stakeholders to understand its organizational hierarchy, escalation levels and communication pathways is an organizational chart (Figure 18). It allows team members, clients, and management to understand who is working on the project and what their roles are in it. A project organization chart is different from a company organization chart (Benjamin, 2018, pp. 22).

The nature of project organization is temporary and dynamic. A complete diagram should reflect not only the organization of the project team, but also its management team and committee, the organization of the key customer and supplier, and the organization of any other team with which the project interacts. If the diagram becomes too complex and large, it can be broken down into smaller diagrams.

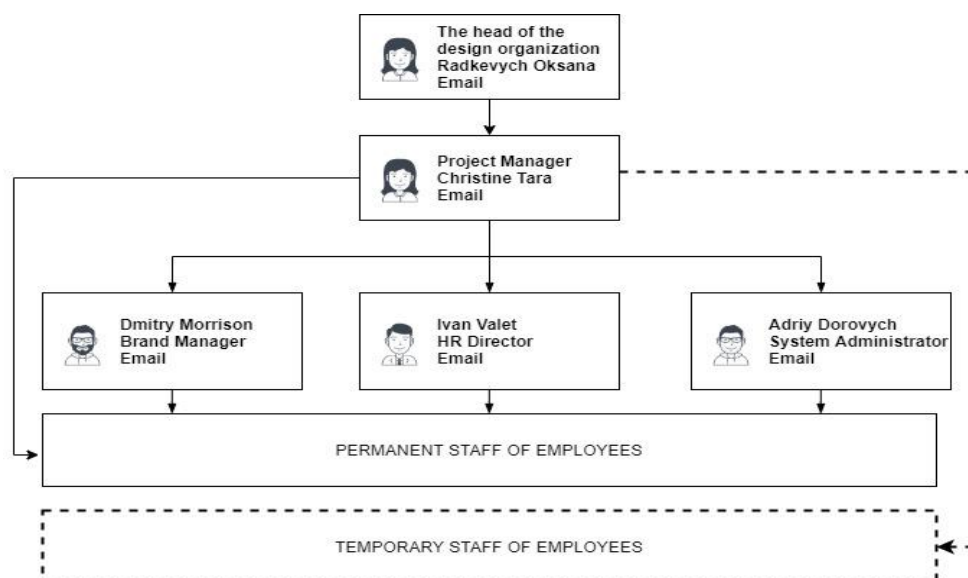


Figure 18. Organizational chart

It is worth using Microsoft Visio to create organization charts. With the help of dotted rectangular frames, the program provides a function for showing the operation of commands separately. Note that color coding is used to identify and display different commands. The diagram is hierarchical in structure, starting at the highest or highest level and branching down to the lowest level. A solid line shows a direct relationship between a supervisor and a subordinate. An indirect communication or relationship is usually shown with a dotted line (arrow). An organizational chart of a project avoids confusion and saves time, and because team members understand the roles and structure of the organization, they are referred to the appropriate person when needed. This helps significantly on large projects where multiple organizations are involved and the team composition is very large and dynamic. The scheme also makes it quicker to identify insufficient numbers of project performers and how the team could use additional staff. By looking at the organization chart, you can assess the complexity of the project and its communication challenges. Such a tool is particularly useful for new entrants as they can better understand the communication paths and hierarchy of the project by looking at the project organization chart.

Conclusions. In project activities, it is important to communicate complex information in a concise format, succinctly to save time and resources. This is possible by using diagrams, charts and graphs that present information in a graphical form. This avoids the use of complex tables and vast amounts of text. Taking into account the fact that a significant number of teachers in vocational education institutions

are practically visual learners, this allows demonstrating what should be worked on, what resources should be used in the process and at what pace of accomplishing certain project tasks. The use of diagrams, schedules, schemes greatly simplifies project management and makes it possible to control the workload of teaching staff. Differentiation of primary and secondary information contributes to the construction of a hierarchy of project data and makes it impossible to distribute important information prematurely.

Within the scope of the research objective analyzed: Gantt chart, which is presented as a bar chart for consistently highlighting information, particularly human resources in the project; a flow chart illustrating the progress of any process from general information to project tasks, graphically depicting the steps that need to be taken to complete a particular project task; "S" curve, in terms of representing the base or actual cumulative cost; bar chart - to identify trends, making comparisons and summarizing the load Pie chart is analyzed, it is used to show the contribution of individual elements to the total project; control chart to check the stability of any project process with and without control limits; organization chart to help understand the organizational hierarchy, escalation levels and communication paths in the project. Based on the above, we can conclude the importance of meaningful and concise presentation of graphic information, which positively affects the quality of the final product.

The problem of communication management in project management of vocational education and training institutions should be considered as a prospect for further scientific research.

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ДІАГРАМИ, ГРАФІКИ ТА СХЕМИ ЯК ІНСТРУМЕНТАРІЙ ПЕРЕДАВАННЯ ПРОЄКТНОЇ ІНФОРМАЦІЇ

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Реферат:

Актуальність: У проєктній діяльності необхідно оперувати великим масивом числових даних із різних проєктних завдань, що обтяжує комунікацію між виконавцями. Додає складності значна кількість проєктної інформації, що може бути неправильно поданою, а тому й незрозумілою для проєктних виконавців. Це створює комунікативні бар'єри, доки доповідач не пояснить суть процесу, зобразивши діаграму, схему чи графік. З огляду на це, графічна подача інформації про проєкт, не замінюючи текстового представлення, є доцільною і значно пришвидшує розуміння принципів його виконання.

Мета: дослідити роль діаграм, графіків та схем як інструментарію представлення проєктної інформації.

Методи: теоретичний аналіз наукових джерел – для з'ясування стану дослідженості цієї проблематики в Україні та за її межами; порівняння – з метою вивчення наукових підходів до розв'язання проблеми; синтез прогресивного досвіду – для представлення проектної інформації у вигляді діаграм, графіків та схем.

Результати: досліджено діаграму Ганта як гістограму для послідовного представлення інформації. Розкрито блок-схему, що ілюструє перебіг будь-якого процесу від загальної інформації до проектних завдань. Висвітлено специфіку Кривої S, як для представлення базової чи фактичної кумулятивної вартості, так і порівняння цих двох показників у часі. Проаналізовано *стовпчасту діаграму*, що використовується для порівнянь та узагальнення груп даних. Розкрито характеристики *ресурсної гістограми* – для планування управління персоналом. Приділена увага *діаграмі запуску*, що використовується для управління якістю та відображає продуктивність представлення проекту в часі.

Особлива увага приділена *діаграмі Парето*, згідно з якою забезпечується аналіз існуючих проблем у проектній діяльності та прийняття рішень щодо контролю її якості. Проаналізовано *секторну діаграму*, яка використовується для показу вкладу окремих елементів у загальну суму проекту. *Контрольна діаграма* – для перевірки стабільності будь-якого проектного процесу як з контрольними межами, так і без них. Висвітлено основні складові *організаційної схеми*, що дає змогу зрозуміти організаційну ієрархію, рівні ескалації та шлях спілкування в проекті.

Висновки: здійснений аналіз діаграм, графіків та схем як елементів проектної комунікації засвідчив позитивний вплив графічної складової на комунікаційний процес.

Ключові слова: *проектна комунікація, діаграма Ганта, блок-схема, крива S, стовпчаста діаграма, ресурсна гістограма, діаграма запуску, діаграма Парето, секторна діаграма, контрольна діаграма, організаційна схема.*

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