Journal of Excellence for Economics and Management Research | ISSN 2572-0171 | Vol 05 , N° 2 (2021) P 249- 268

Quality problem solving with PDCA cycle

Boulesnane Foulla*

University of Algiers 3, foulla.bel@gmail.com,

Received: 9/15/2021 **Accepted**: 11/19/2021 **Published**: 12/16/2021

Abstract:

This study identified that is very essential to apply the PDCA cycle for solving problem quality in any organization, regardless its type or size.

PDCA cycle and basic quality tools were used to analyze the quality problems and implement a successful solution. PDCA cycle is an iterative four steps managing technique, the Plan phase consisted of investigating the problem. The Do phase consisted of implementing the corrective actions and the effectiveness of the improvements were verified in the Check phase. The final phase of PDCA was Act where other opportunities for implementing the corrective actions would be sought. In every phase of PDCA cycle, we need to use the seven basic quality tools.

Keywords: PDCA, problem, problem quality, basic quality tools, solving problem

JEL Classification Codes : M54

* ***Corresponding author***

1. INTRODUCTION

Various organizations of all kinds work hard to achieve their goals and raise the quality of their products, and in the midst of that, they face many problems from time to time, and this puts them in front of the challenge of continuing to provide better performance, and achieving customer satisfaction.

The business world is full of problems that need solutions, and through Total Quality Management, problem solving is done in a way that prevents it from recurring again, and leads to improving the product or process.

This research is very important because it studies one of the most known techniques used to solve problems is the PDCA cycle, which is an integral part of ISO 9001v2015. Companies going for ISO 9001 will automatically integrate PDCA cycle. This cycle is used in different cases for continuous improvement or any change. It used also for quality problem solving, and this is what we will address in this research. Therefore, we raise the following problematic:

❖ **How is the PDCA cycle used in solving the problems facing different organizations?**

The aim of this research is introduce a methodology for using the PDCA cycle to solving problem quality, with support tools.

This study has been based on the descriptive and analytical method, by presenting and analyzing the basic elements, it is also based on studies, research and writings that dealt with this subject. In order to answer the problematic posed, we will address the following points:

I-Concepts on quality problem solving:

II-Quality problem solving:

III-Case study

2. Concepts on quality problem solving:

2.1. Quality problems definition:

The Concise Oxford Dictionary (1995) defines a problem as: “A doubtful or difficult matter requiring a solution”, and “Something hard to understand or accomplish or deal with (skillsyouneed.com)

A problem is any situation in which what exists does not match what is desired (Lynne, 1997, p. 7), or put another way, there is a discrepancy between the current state of affairs and the one desired, the greater the disparity between the two, the greater the problem.

A quality problem is defined as any instance where the desired quality characteristic is not present or not up to the intended level. In other words, it is an instance of failure to conform to standards or specifications.

It can also describe as the quality gap: between what is (current state)? And, what is desired (desired state)?

2.2. Types of quality problems:

The identification of the different types of quality problems facilitates the task of solving the main problems raised by the situations faced by the organizations, thus making them able to identify the tools and techniques appropriate to the task. Knowing the five types of quality problems will also help practitioners gain access to a wealth of exploratory knowledge related to solving problems with high quality, this knowledge is arguably the most valuable available resource for solving quality problems in the real world. These types are:

2.2.1. Conformance problems: The key feature of a conformance problem is that there is a known right way of doing things. The system has worked before, but now, for some reason, it is not performing acceptably. One or more aspects of the system—its inputs or processing activities—have deviated from the norm, so outputs are not as they should be. Problem solving is a matter of finding the causes of deviations and restoring the system to its intended mode of functioning.

The identification of conformance problems is aided by the existence of standards. System inputs, works in process and outputs can be compared with standards— problems being identified when mismatches are observed. Statistical process control, a powerful means of identifying conformance problems, is much less useful for identifying other types of quality problems. The major challenge with conformance problems is to identify the causes of deviations or defects.

Due to the existence of strong standards, conformance problems are the easiest of the five types of quality problems to identify and solve. Nonetheless, the difficulty of establishing the causes of deviation in complex performance systems can make these problems extremely challenging. (Smith F. , 2000, pp. 45-46)

2.2.2. Unstructured performance problems: An unstructured performance problem (UPP), is a type of problem that involves systems or processes that are not well specified by standards and that are not performing acceptably from the standpoint of product users or other stakeholders. A sales below the budget is a typical UPP. Problem identification is the most difficult step of the process, since one cannot simply monitor for deviations from the standard. The major challenges in solving problem are determining customer need and finding the causes of the poor performance. (Henderson, 2002)

2.2.3. Efficiency problems: It reflects the interests of system owners and operators. This problem consists of operations that are more costly than the system owners desire them to be and can pose unsafe or undesirable conditions for the workers. cost efficiency is the most common concern for this category. Employees have a critical role in the identification of the problem since they know more about the wasteful and unsafe production procedures. When solving efficiency problems, one must center on identifying and eliminating unnecessary activities and finding less costly ways of performing the needed functions. (Henderson, 2002)

2.2.4. Product design problems: Product design problems require one to create a system or artifact that satisfies user needs. These are familiar concerns, especially in competitive, technology driven industries. Most organizations have new product development departments, though product design work increasingly involves a broader set of participants. One key task in product design is requirements determination, identifying user needs and other demands that the intended artifact must satisfy. Quality function deployment is the quality movement's primary contribution to this endeavor. The technique maps user needs into product characteristics and, from there, into production procedures and specifications. The major challenge in product design is design itself, envisioning and creating artifacts. This is a top-down process that begins with the generation of high level design concepts. A promising concept is selected for development, being elaborated into components and subcomponents. Finally, a detailed design specification of an acceptable artifact is achieved.

Effective product design reaches beyond expressed customer needs—customers don't always know what they want, much less what they can have—to consider the product's total context of use and any environment it can be expected to encounter during its life cycle. Increased competition and the faster pace of innovation in many industries has motivated companies to shorten the product design process. (Smith F. , 2000, p. 47)

2.2.5. Process design problems: A process is an organized set of activities aimed at achieving a goal. Process design is the task of devising processes that achieve their goals. Arguably, if all processes were correctly designed, there would be few problems of any kind. Organizations had historically ignored their internal processes. Process inadequacies were only identified as a result of serious performance problems. During the past 20 years, the quality movement has changed this thinking. It has fostered increased management awareness of organizational processes, establishing process design and improvement as ongoing requirements for organizational success. If the identification of process design problems is institutionalized, problem definition will continue to be a challenge. Effective definitional activity determines how the existing process operates, how comparable functions are performed in other organizations and what process possibilities have been created by technological advances.
The virtues of process design methods not withstanding process improvements usually result from heuristics. These pieces of advice exist for all aspects of a process, including process flow and layout, input screening and control, exception handling, task assignment and scheduling, setup, coordination and consolidation of activities, process triggers, and the handling of interruptions and delays. (Smith F. , 2000, pp. 47-48)

2.3. Quality problem Solving and its importance:

Problem solving is fundamental to total quality, problem solutions will decrease the number of problems that occur, problem solving is the process of analyzing the situation and developing a solution to bridge the gap (referenceforbusiness.com), or it is the action taken to close the gap between a desired condition and the actual level of the condition. (Lynne, 1997, p. 119)

The main idea is that any problem-solving activity will benefit and eliminate obvious and hidden barriers.

The point is that in total quality jargon, a problem is solved only when its recurrence has become impossible or significantly less probable. That will always be objective of total quality problem solving. Any problem that is merely fixed by restoring the situation to what it was before the problem was manifested will return again. In those organizations that have adopted total quality, problems are solved once and for all. When problem solutions lead to process or products or services Improvement: (David L, 2014, p. 292)

- Product or service quality Improves;
- Costs decrease (through less waste and warranty action);
- Customer satisfaction improves;
- Competitiveness improves;
- The probability for success improves.

2.4. Principles helping to solve quality problems:

Four main principles define the approach presented in this monograph for ensuring and improving quality and for resolving quality problems as they arise. These are summarized below: (David L, 2014, pp. 8-9)

2.4.1. Focus on client needs: Client needs and desires should drive the planning and performance of any activity. Ensuring quality begins with knowing who the clients are and understanding their needs and expectations. Within this idea of "client," every worker plays the complementary roles of serving clients and of being a client.

2.4.2. A focus on Systems and Process: All productive work results from processes. A process is a series of steps or tasks that turns people, methods, and materials into products and services. Processes operate within systems: a system is a set of processes that function together.

Quality problems in one process are often due to a deficiency in one or more of the system's related processes or to a failure in coordination of the interrelated processes. If the processes are deficient, the outcomes will likely be deficient as well. Poor quality is often the result of poor job design (processes that do not work or take too long) or the failure of leadership to provide a clear purpose for activities. Quality improvement requires an understanding of the relevant processes and their acceptable levels of variation.

2.4.3. A focus on Data-based Decisions: Improving processes requires information about how they function. Decisions about problem areas and improvements should be based on accurate and timely data, not on assumptions. Often, all the facts may not be immediately available, and data need to be collected. Insights should be verified by data whenever possible, although informed judgment about problematic processes is a valuable starting point.

For example, instead of *assuming* what the client thinks, feels, and needs, the quality assurance team collects information on clients' needs and levels of satisfaction. Data are needed throughout the problem-solving process to 1) help to detect and define problems, 2) identify the root causes of problems or error-prone processes, and 3) monitor effects of implemented solutions to ensure they are working. Care needs to be taken to ensure both that sufficient data are collected to have the essential facts and that too much time not be spent collecting more data than are really needed.

2.4.4. A focus on Participation and Teamwork in Quality Improvement: For quality improvement to succeed, workers must participate in making changes in the organization's systems and processes. Empowering workers to carry out quality improvement has two advantages. First, those conducting the daily work often have a better sense of where things go wrong and which corrective actions may be feasible. Second, people are more likely to carry out changes when they feel they have had a part in developing the solutions.

3. PDCA cycle:

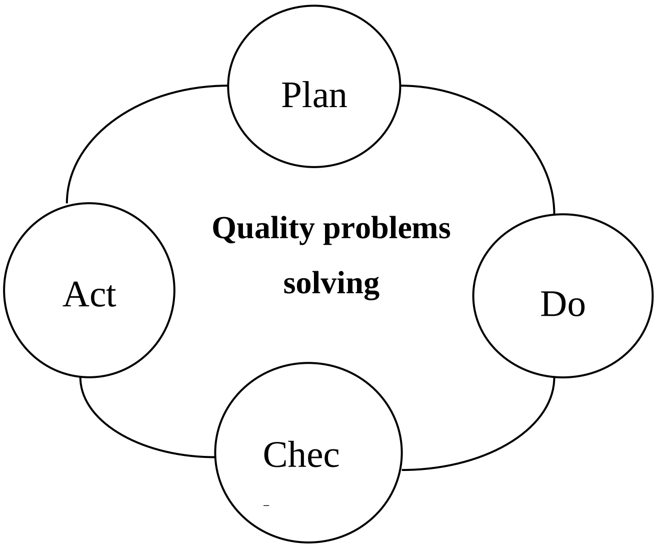
3.1. Historical perspective

Plan-Do-Check-Act (PDCA) has its origins in the scientific method that has evolved over 400 years. Shewart turned the linear specification, production and inspection process, which corresponded to the scientific process of acquiring knowledge, into a circular path. This, he advocated, would represent the idealized case where no evidence is found on inspection to indicate a need to change the specification no matter how many times the three steps are repeated. This is shown pictorially in Figure 5.3 (Shewhart, 1939; republished 1986). There is no Act stage in this cycle where inspection finds no errors outside specification limits. Were errors to be found, the cycle is not formed. Moen and Norman explain how Deming built on Shewhart's ideas and introduced them in his lectures in Japan in the 1950s and from this how the Japanese modified the Deming cycle to create PDCA (Moen & Norman, 2010). The PDCA

concept as explained in ISO 9001:2015 is not quite what was described by Masaaki Imai in his explanation of the PDCA cycle (Imai, 1986), and according to Moen and Norman, Deming commenting on the PDCA cycle said, “What you propose is not the Deming cycle.”
It appears that Deming disliked the word *check* because he understood it to mean “hold back” and not what he advocated for this stage in the cycle which was “study and learn”. Neave suggests that the Inspection stage of the Shewart cycle may be divided into two steps, Observation and Analysis, rather than incorporating the Act stage, and both the Shewart cycle and Deming’s cycle is drawn in a way that makes clear the sequence of steps may be repeated (Neave, 1990). The cycle advocated by Deming was Plan-Do-Study-Act and is often illustrated as in Figure 5.4 . Deming labeled the figure as “A flow diagram for learning and for improvement of a process or a product” PDCA is best defined as applied research, where the emphasis is on getting things to work well, without being overly concerned about the theoretical foundation. The real value of the PDCA approach is that it encourages practical problem analysis by people who are knowledgeable about a given process. (Hoyle, 2018, p. 77)

The PDCA cycle consists of four major components, each of which can be subdivided into the necessary step-by-step problem-solving activities. Just as a circle has no end, the PDCA cycle should be repeated again and again for continuous improvement.

Fig1: PDCA cycle



Source: made by researcher

3.1.1. Plan: The first step in the PDCA cycle is Plan. This step includes defining problems and collecting all relevant data. Then the team has to find out the problems’ root causes to develop an actionable tested plan. However, identifying the key stakeholders and understanding customers’ expectations are mainly focused first of all. Since the PDCA requires many steps from defining, planning, testing, analyzing, etc., a multidisciplinary or cross-functional team should be established. This team includes members who have different main functions, who can communicate and interact with each other frequently toward the main goal. The Plan phase normally consumes more time than others due to it should be done very carefully in clarifying the problem, finding and analyzing the root causes, developing solutions or countermeasures in an action plan. (Vi Nguyen, 2020, pp. 5-6)

3.1.2. Do: In this phase, it is intended to implement the action plan, select and document the information. Also, unexpected events, learned lessons and the acquired knowledge must be considered (Arturo, 2018, p. 4).

3.1.3. Check: Step equals checking, testing, whether solutions introduced to a company brought adequate results. The measurements are taken and they are compared with the values folded in the plan. Check sheets, control charts, can be used to help. If the implementation of solutions proved to be appropriate, it is followed by PDCA cycle step "Act", if not - one shall return to step "Plan" (this is a critical area in the process of improvement). (Arturo, 2018, p. 4)

3.1.4. Act: In this step, it uses the implemented solutions. After the step 3 proved that they had brought the expected result which started their standardization and monitoring of their activities. The instructions for employees are displayed in a visible and comprehensible form. More-over, improvements to the existing procedures for the injection process of the photo frames are introduced. In these procedures, besides fixed points, are precisely characterized ways to solve problems and persons responsible for their implementation is specified. (Arturo, 2018, p. 22)

3.2. Steps in general problem solving process:

3.2.1. Define the problem: The process of forming a definition to the problem is directly related to the identification the problem, problem identification is the process by which one comes to believe that a problem exists. Problem definition answers the question ‘‘What is the problem?’’ (Henderson, 2002, p. 16)

The purpose of this Step is to state clearly the targeted “problem.” An operational definition of a problem or quality deficiency expresses the difference, in specific and observable terms, between the current and desired state of affairs. A clear problem statement helps to focus problem-solving efforts throughout the remaining steps. (Lynne, 1997, pp. 24-25)

One way of maintaining an open mind, therefore, is to formulate the problem statement so that it does not include any hint of its cause or potential solution. A problem statement should clarify the exact target of quality improvement, indicating clearly what is deficient, not why or how to fix it.

There are three steps to defining the problem operationally: (Lynne, 1997, p. 25)

a-Describe what the problem is and how you know it is a problem;

b-Determine the boundaries of the problem: where the problem begins and ends;

c-Check to see that the statement does not assign any blame or include an implied cause or solution.

3.2.2. Data collection: This step consists of determining all knowable facts about the situation (Henderson, 2002, p. 17). An effective, ongoing quality improvement system depends upon a management and information system that routinely monitors important service quality indicators. Such a monitoring system provides timely data that can point to existing or emerging problems and potential areas for improvement. Besides the routine monitoring system, several other sources can provide information about quality deficiencies. These can be formal sources, such as surveys or sampling of existing records, or more informal methods, such as interviewing staff or clients. Flow charting a process that needs improvement can also reveal specific problems (Lynne, 1997, p. 19).

3.2.3. Analyze the problem and identify the root causes: After a problem definition and information gathered from step 2, ‘‘this is the step in which the organization will attempt to understand more about the problem or quality deficiency’’ (Lynne, 1997, p. 33).

We now have to determine the location, geographically and within the process or product, of problem's cause. Where did the problem manifest itself? Was it in a production process? Was it in the test department? Was it in a review of a process or design? The intent of this step is to move our attention upstream to where the problem's cause took life. That could be far removed from where the problem was first detected. Caution must be taken at this step. It is often easy to determine a cause that seems to fit the problem perfectly and yet does nothing to prevent the problem from recurring. Remember, in addition to eliminating the immediate problem, we want to improve the process in a manner that will prevent a later recurrence of the problem (David L, 2014, p. 296).

3.2.4. Develop solutions: Based on the causes identified above, various factors requiring correction are identified. Alternative solutions to solving the problem may be identified and shortlisted through employee suggestion, literature review and benchmarking. In the long term, research and innovation may provide better solutions (Salleh, drdollah.com). It is important to work together in team to generate solutions.

Once a list of potential solutions has been generated, the evaluation process can begin. First a list of criteria for judging all solutions equally must be chosen. It is vital to eliminate personal bias towards particular solutions as well as to utilize a consistent set of criteria to evaluate all solutions fairly. It is important to have research and logical reasons for the criteria chosen as well as factual support for the rakings given to a particular solution for each criteria, and to remember that the criteria that are used to judge the solutions are reflective of the choices being made. Each criteria is a ruler or a gauge by which to measure an outcome. Different rulers will yield different results so be sure to choose the proper rulers as well as use them properly. In order to choose the correct ruler and interpret it in the correct way, it is necessary to understand many different disciplines and the tools they use. In the end, however, each individual must have good decision-making skills to choose and use criteria (Web.njit.edu/2lipuma/GPS.htm).

After selecting the best solution, it is necessary to give some thought to the way in which it might be implemented. Giving insight into funding, potential problems with implementing the solution, and the time frame of the solution is necessary for any workable solution to a problem. Not all solutions can be implemented. Unforeseen problems may arise as solutions are tested and put to work. Many times, unexpected resistance to solutions can be encountered. Other times, unacceptable results can require that another solution be used.

In some circumstances the problem may have been originally selected incorrectly, have been misunderstood, or have changed as a result of research or altered circumstances. In the end, mistakes happen and the action plan helps the problem solver be prepared for such eventualities. In any event, the action plan can be used to make others aware of potential problems that might be faced while putting the selected solution into effect. Even when solving a current problem, this process will automatically assist the problem solver in thinking of potential problems and thus assist in avoiding unwanted outcomes. Whatever the outcome, it is vital to understand that the choices made during this entire process rely upon research (Web.njit.edu/2lipuma/GPS.htm).

3.2.5. Evaluation of process: The last stage is about reviewing the outcomes of problem solving over a period of time, including seeking feedback as to the success of the outcomes of the chosen solution. The final stage of problem solving is concerned with checking that the process was successful. This can be achieved by monitoring and gaining feedback from people affected by any changes that occurred. It is good practice to keep a record of outcomes and any additional problems that occurred (Web.njit.edu/2lipuma/GPS.htm).

The quality problem solving is a continuous process that keeps corporations producing more effective and efficient products and services (Henderson, 2002, p. 28).

3.3. Tools for quality problem solving:

These tools and techniques can be used in two different ways (Zairi, 1991, p. 88):

- ✓ **Reactive role:** A problem has been identified and a process seeking to solve it is carried out;
- ✓ **Proactive role:** The continuous search for improvement by isolating possible bottlenecks and seeking to solve them through a process using TQM tools and techniques.

3.3.1. Flowchart:

Flowcharts are effective means of communication medium which can be easily understood. Team members can clearly identify what could be done to the process at each level. Non value-added activities present in the process can be easily determined and can be separated from the process (Figure 1). Steps involved in constructing process maps are given as follows (Jones, 2014, p. 212):

- ✓ Determine the process limits: In order to chart the process, it is essential to determine the start of the process and end of the process ;
- ✓ Define the process steps: Use brainstorming to determine the steps for new process;
- ✓ Sort the steps in the order of their occurrence in the process;
- ✓ Place those steps in the order of the symbols and create a chart;
- ✓ Evaluate those steps for efficiency and problems.

3.3.2. Cause-and-effect diagram:

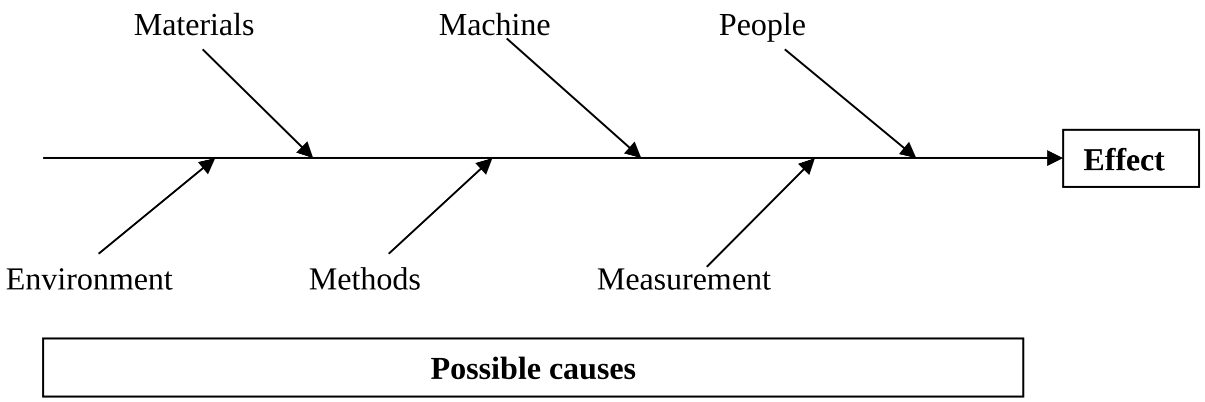
The cause-and-effect diagram graphically illustrates the relationship between a given outcome and all the factors that influence the outcome. It is sometimes called an Ishikawa diagram (after its creator, Kaoru Ishikawa) or the fishbone diagram (due to its shape).

The cause-and-effect diagram displays the factors that are thought to affect a particular output or outcome in a system. The factors are often shown as groupings of related sub factors that act in concert to form the overall effect of the group. The diagram helps show the relationship of the parts (and subparts) to the whole by (Duffy, 2013, pp. 50-51):

- ✓ Determining the factors that cause a positive or negative outcome (or effect);
- ✓ Focusing on a specific issue without resorting to complaints and irrelevant discussion;
- ✓ Determining the root causes of a given effect;
- ✓ Identifying areas where there is a lack of data.

This tool is performed after brainstorming session by the collective team members seeking to improve the process (Jones, 2014, p. 213).

Fig 2: Cause-and-effect diagram



Source: made by researcher

3.3.3. Check sheets:

A check sheet is used to record the frequency of specific events during a data collection period. That data can then be converted into readily useful information. The most straightforward way to use a check sheet is simply to make a list of items that you expect will appear in a process and to make a checkmark beside each item
when it does appear. This type of data collection can be used for almost anything, from checking off the occurrence of particular types of defects to counting expected items (for example, the number of times the telephone rings before it is answered). Check sheets can be coupled to histograms to visually depict the information collected. A check sheet is a simple way to (Duffy, 2013, pp. 54-56):

- ✓ Collect data with minimal effort;
- ✓ Convert raw data into useful information;
- ✓ Translate perceptions of what is happening into what is actually happening.

The basic steps involved in creating a check sheet are as follows:

1- Clarify the measurement objectives. Ask questions such as "What is the problem?" "Why should data be collected?" "Who will use the information being collected?" and "Who will collect the data?"

2- Create a form for collecting data. Determine the specific things that will be measured and write them down the left side of the check sheet. Determine the time or place being measured and write this across the top of the columns;

3-Label the measure for which data will be collected;

4-Collect the data by recording each occurrence on the check sheet as it happens;

5-Tally the data by totaling the number of occurrences for each category being measured;

6-The data from the check sheet can then be summarized in a number of ways, such as with a Pareto chart or a histogram.

3.3.4. Control chart:

A control chart is a form of traffic signal whose operation is based on evidence from the small samples taken at random during a process. A green light is given when the process should be allowed to run. All too often processes are 'adjusted' on the basis of a single measurement, check or inspection, a practice that can make a process much more variable than it is already. The equivalent of amber light appears when trouble is possibly imminent. The red light shows that there is practically no doubt that the process has changed in some way and that it must be investigated and corrected to prevent production of defective material or information. Clearly, such a scheme can be introduced only when the process is 'in control'. Since samples taken are usually small, there are risks of errors, but these are small, calculated risks and not blind ones. The risk calculations are based on various frequency distributions. These charts should be made easy to understand and interpret and they can become, with experience, sensitive diagnostic tools to be used by operating staff and first-line supervision to prevent errors or defective output being produced. Time and effort spent to explain the working of the charts to all concerned are never wasted (Oakland, 2014, p. 282).

There are several types of control charts, but all have the same basic structure. The two main categories of control charts are those that display attribute data and those that display variables data (Duffy, 2013, p. 59):

• Attribute data. This category of control chart displays data that result from counting the number of occurrences or items in a single category of similar items or occurrences. These "count" data may be expressed as pass/fail, yes/no, or presence/absence of a defect. Charting the proportion of failed items results in the ability to observe whether failures are in control or out of control.

• Variables data. This category of control chart displays values resulting from the measurement of a continuous variable. Examples of variables data are elapsed time, temperature, and radiation dose. Explanation of these charts types and their characteristics requires more space than is available in this publication.

The benefits of control charts are that they (Duffy, 2013, p. 60):

• Help organizations recognize and understand variation and how to control it;
• Help identify special causes of variation and changes in performance;
• Keep organizations from trying to fix a process that is varying randomly within control limits (that is, no special causes are present);
• Assist in the diagnosis of process problems;
• Determine whether process improvements are having the desired effects.

3.3.5. Pareto charts:

The Pareto chart is a very useful tool wherever one needs to separate the important from the trivial. The chart, first promoted by Dr. Joseph Juran, is named after Italian economist and sociologist Vilfredo Pareto (1848–1923). He had the insight to recognize that in the real world a minority of causes lead to the majority of problems. This is known as the Pareto Principle. Pick a category, and the Pareto Principle will usually hold. For example, in a factory you will find that of all the kinds of problems you can name, only about 20% of them will produce 80% of the product defects: Eighty percent of the cost associated with the defects will be assignable to only about 20% of the total number of defect types occurring. Examining the elements of this cost will reveal that once again 80% of the total defect cost will spring from only about 20% of the cost elements. All of us have limited resources. That point applies to you and to me, and to all enterprises—even to giant corporations and to the government. This means that our resources (time, energy, and money) need to be applied where they will do the most good. The purpose of the Pareto chart is to show you where to apply your resources by distinguishing the significant few from the trivial many. It helps us establish priorities (David L, 2014, p. 258).

3.3.6. Scatter diagram:

A scatter diagram is a chart in which one variable is plotted against another to determine whether there is a correlation between the two variables. These diagrams are used to plot the distribution of information in two dimensions. These variables are said to be positively correlated; that is, if one increases, so does the other. If the line in a scatter diagram has a negative slope, the variables are negatively correlated; that is, when one increases, the other decreases, and vice versa. When no regression line can be plotted and the scatter diagram appears to simply be a ball of diffuse points, then the variables are said to be uncorrelated. The specific utility of finding correlations is to pursue causal relationships among variables and ultimately to find the root causes of problems.

PDCA	Steps	Tools
Plan	**Problem definition and clarification:** -Identify the problem -Identify teem -Define the goal	-Flow chart -Pareto charts
	Data collection	-Check sheet -Observation record
	Analysis: -Look for the causes -Visualize the causes -Prioritize the causes -Validate the main causes	-Brainstorming -scatter chart -Ishikawa diagram -Control chart -Pareto charts
	Action plan: -Look for solutions -Select solutions -Write an action plan	-Brainstorming -Flow chart
Do	-Implement the solution -Follow the plan	-Flow chart -Check sheet -Histogram
Check	-Check Implementation of plan -Check effects of implementation	-Pareto chart -Check sheet -Histogram
Act	-Continue improvement -Standardization	-Brainstorming

It's crucial to remember that scatter diagrams show only that a relationship exists between two variables, not that one variable causes the other. Further analysis using advanced statistical techniques can quantify how strong the relationship is between two variables. (Duffy, 2013, pp. 94-97)

3.3.7. Histogram:

Histograms are charts that indicate how often some event is likely to occur by showing the pattern of variation (distribution) of data (Lynne, 1997, p. 100). A histogram is used for the following (Campus, p. 238):

- ✓ Making decisions about a process, product or procedure that could be improved after examining the variation.
- ✓ Displaying easily the variation in the process.

Histograms are limited in their use due to the random order in which samples are taken and lack of information about the state of control of the process. Because samples are gathered without regard to order, the time-dependent or time-related trends in the process are not captured. So, what may appear to be the central tendency of the data may be deceiving? With respect to process statistical control, the histogram gives no indication whether the process was operating at its best when the data was collected. This lack of information on process control may lead to incorrect conclusions being drawn and, hence, inappropriate decisions being made. Still, with these considerations in mind, the histogram’s simplicity of construction and ease of use make it an invaluable tool in the elementary stages of data analysis (Campus, p. 242).

3.4. Mechanism of PDCA cycle for solving problem quality:

During this step, every action can be supported by tools and methods as following:

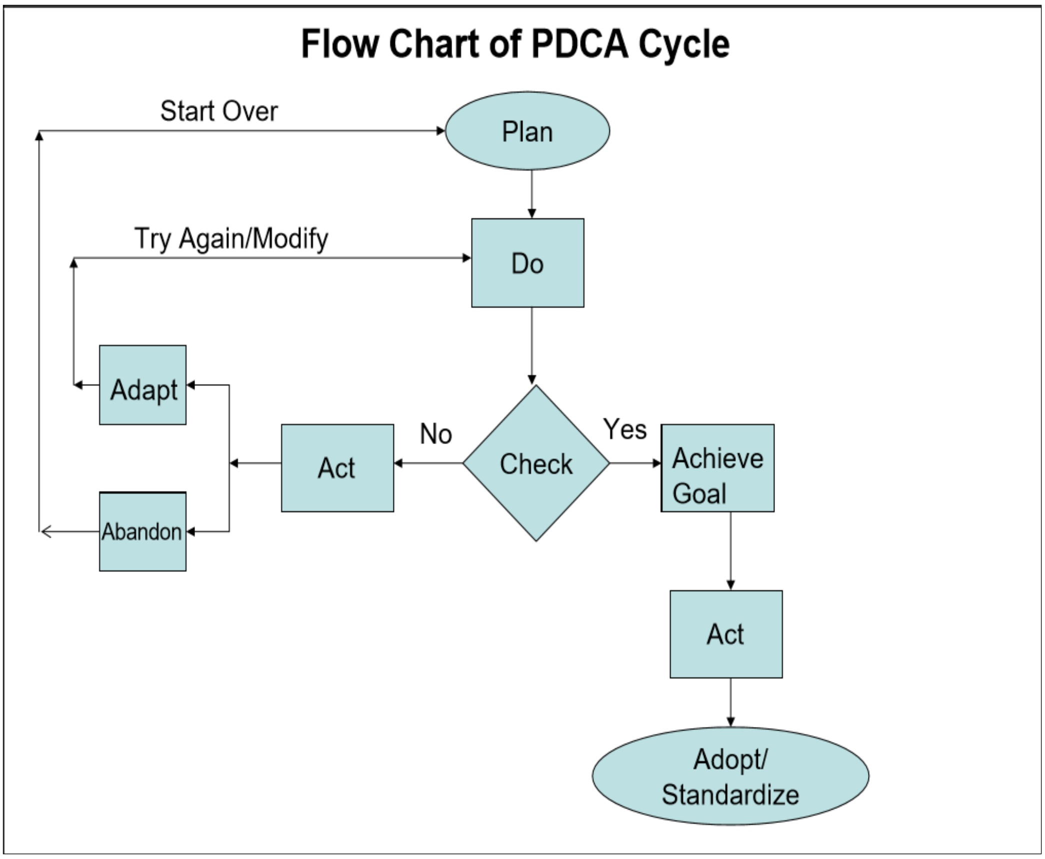
Table 1: Mechanism of PDCA cycle for solving problem quality

Source: made by researcher

If the change did not work, then this is time to go through the cycle again with a different plan. Once the process is successful, now you can implement what was learnt during the test cycle.

Take what you have learnt from this to inform the planning for new improvements – the cycle now begins again (werryworkforce.org).

Fig 3: Flow chart of PDCA cycle



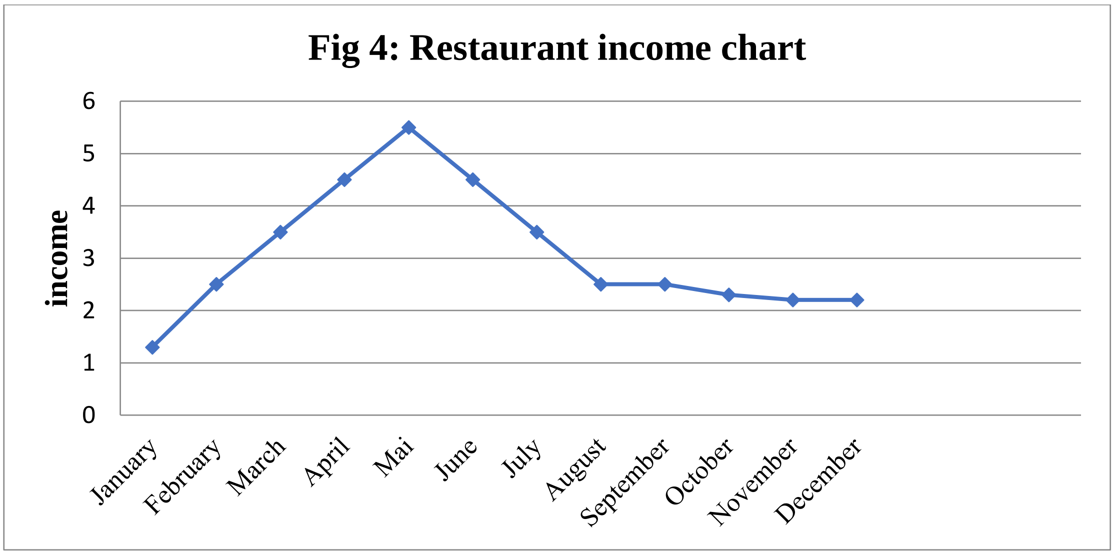
Source: https://werryworkforce.org/quality-improvement/pdsa

4. Results and discussion:

To solve the problem of low incomes in a restaurant, a team was formed to address this problem.

Step 1: Plan

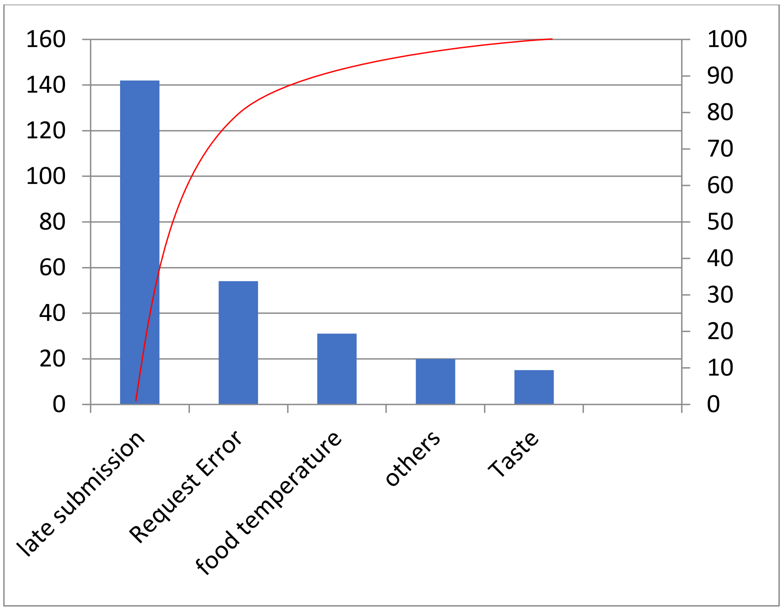
1-By observing the growth of incomes, it was found that there were two stages, a stage characterized by the rise of incomes to reach their peak, and then in the second stage, incomes became in a state of decline.



Source: made by researcher

2-The Pareto chart was used to identify the most important customers complaints.

Fig 5: Restaurant complaints

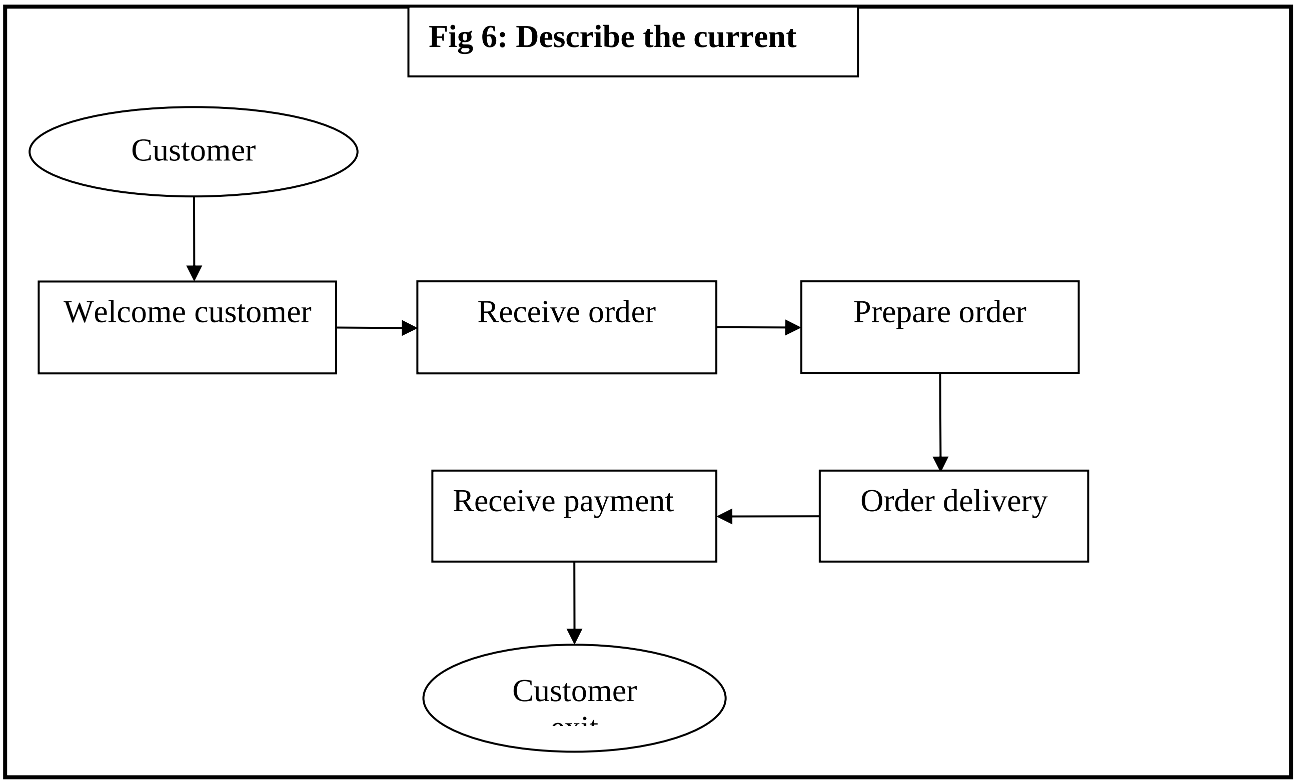


Source: made by researcher

Through the Pareto chart, the delay in submitting an order was found to be the main complaint of customers.

3-By tracing the process of serving meals through the process flow chart, we find the following:

Fig 6: Describe the current

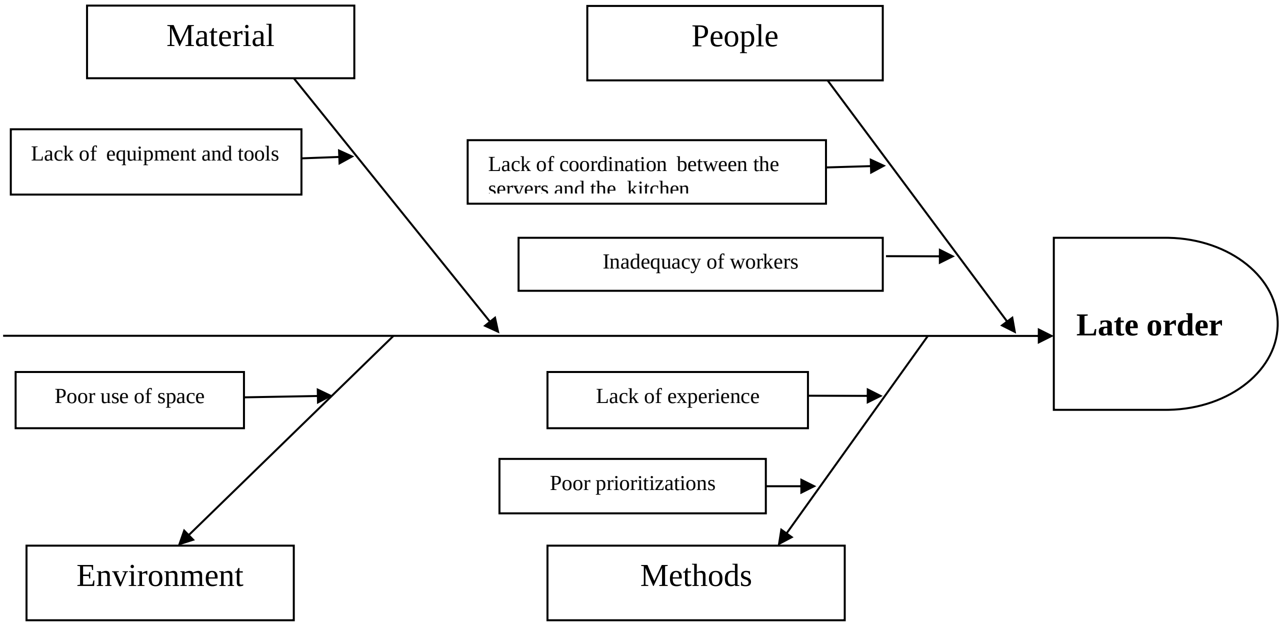


Source: made by researcher

There is a fault in the process, so we will look for the main reason why the process is slow, so we will find the root cause using the cause-effect chart as following:

4- After a brainstorming session, the following chart was developed:

Fig 7: Cause-effect chart



Source: made by researcher

According to the cause-effect chart, the main problems are:

- ❖ Lack of coordination between the servers and the kitchen;
- ❖ Lack of experience.

5- After observing the process, it was found that the average customer waiting time is 30 minutes.

This period increases in rush hours when the number of customers increases, and it is the same time in which the percentage of errors increases

6-The goal, then, would be to reduce the waiting time to 15 minutes.

7-The solutions put forward are:

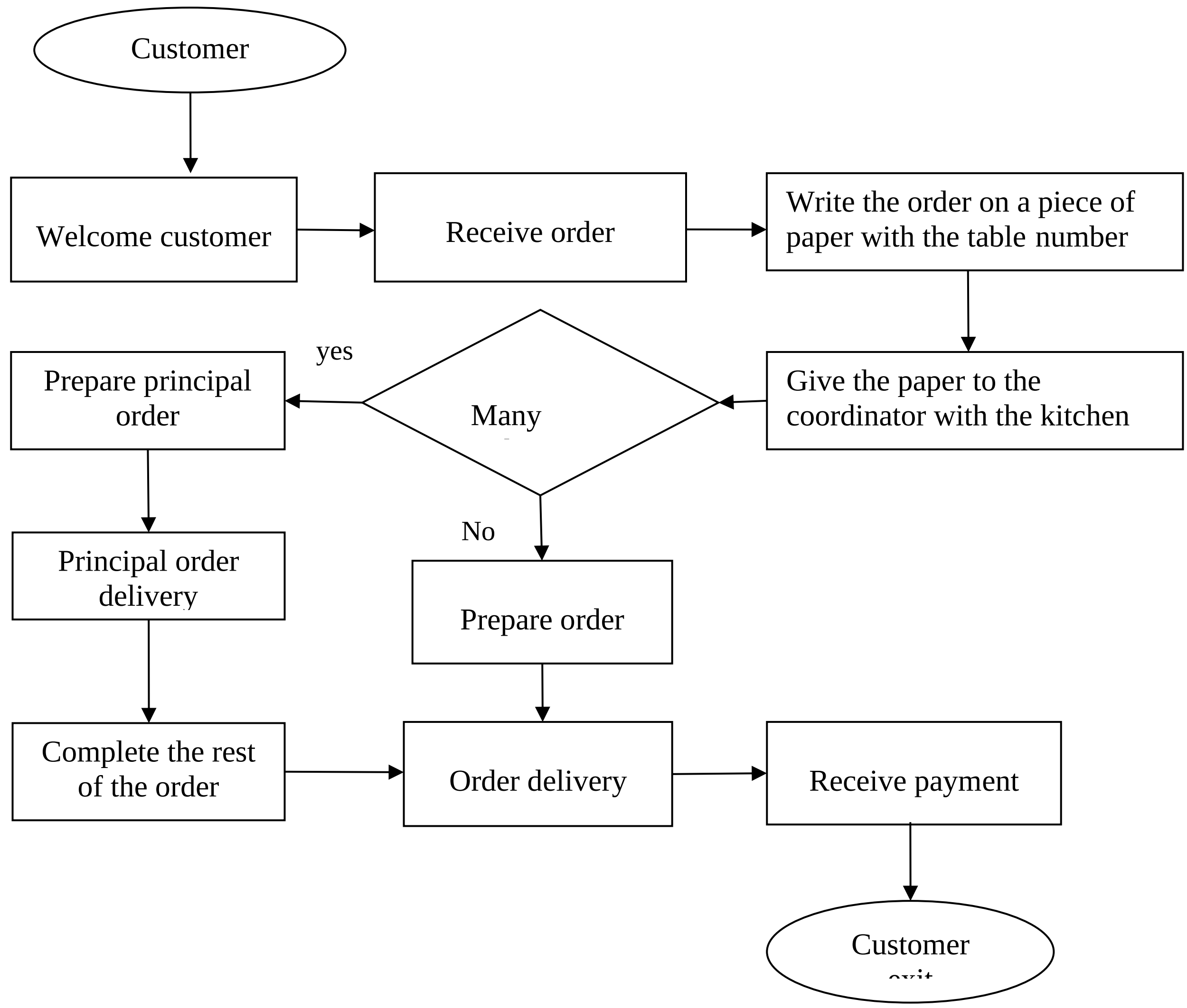
*Putting an order coordinator to be an intermediary between the kitchen and the food providers

*Training the workers on the work plan

*Table numbering

8-The process becomes as follows:

Fig 8: Description of the process plan



Source: made by researcher

Step 2: Do: We implement the solution by following the plan.

Step 3: Check: After the implementation of the solution we evaluate the result, we will use the Histogram to verify the change in complaints customers:

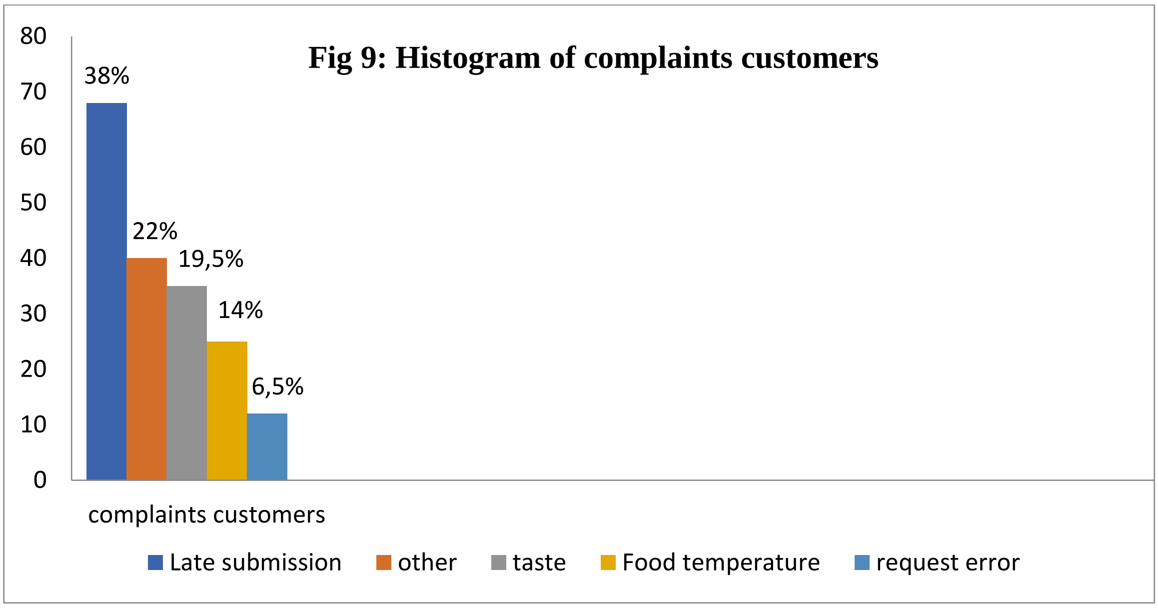


Fig 9: Histogram of complaints customers

Source: made by researcher

Through the Histogram we see that the complaints customers reduce to 38%.
The results show that the solution was successful, by:

- ❖ reducing the average time for serving oeder to 15 minutes;
- ❖ reducing delivery errors;
- ❖ increase the income to about 55000 DA in December.

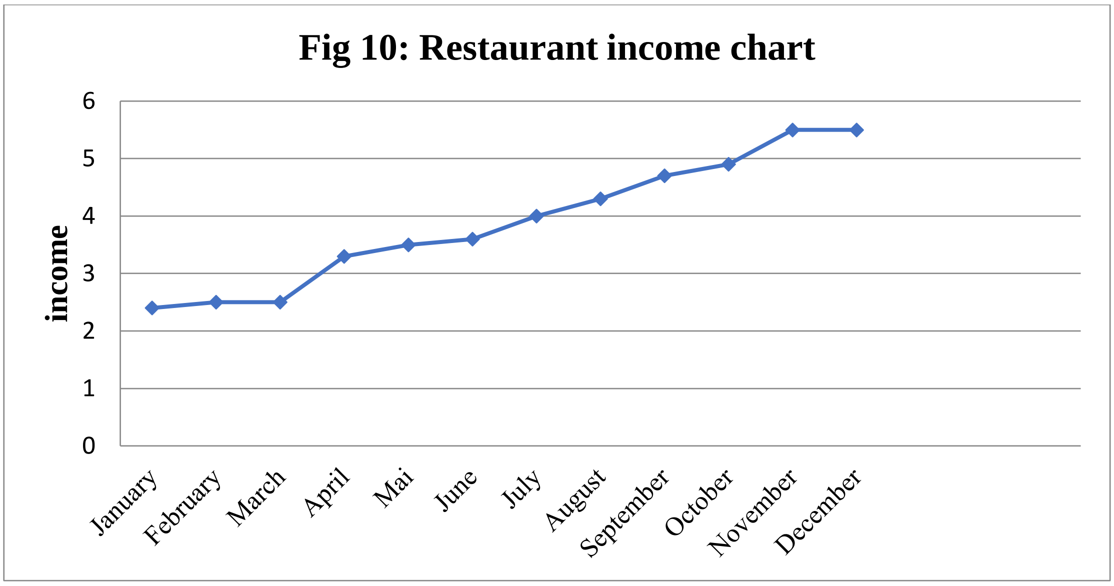


Fig 10: Restaurant income chart

Source: made by researcher

Step 4: Act: After evaluating the results, it was found that the changes that were made were successful, so it was decide the following:
Continuing to train workers and increasing coordination among them to improve the performance and achieve the best results.

5. CONCLUSION

The PDCA cycle is a cyclic process that bringing a change which, when implemented and repeated, would yield repeated improvements in any process, it is used also for preparing data collection and analysis so as to verify and prioritize problems or root causes to solve the problems faced by the organizations

The PDCA cycle provides a focused procedure for the solving quality problem, through four steps iterative, using one or more of the seven basic quality tools for every step.

This research focused on the benefits of PDCA cycle in quality problem solving, it introduces the methodology to practice this method with support tools (the seven basic quality tools), also it provides understandable guidance with a successful application of PDCA for late order problems in restaurants, and we can summarized what we found in this article in the following points:

- ✓ PDCA is a systematic tool used to analyze the fundamental problems before trying to solve them;
- ✓ Collect data over time;
- ✓ It has an important role in any organization regardless of its type or its size;
- ✓ The implementation of PDCA cycle is simple and easy;
- ✓ PDCA cycle is an iterative four steps managing technique (Plan, Do, Check, Act);
- ✓ The plan phase is used to made the most of the time and effort;
- ✓ The PDCA cycle provides permanent solutions to the problems occurred;

6. Bibliography List:

1. Books :

-David L, Goetsch, (2014). **Quality management for organizational excellence: introduction to total quality**, Pearson education limited, England

-David Hoyle. (2018), **ISO 9000 Quality systems Handbook,** Taylor and Francis group, New York:

-Duffy, Grace. L, (2013), The ASQ Quality Improvement Pocket Guide, Wisconsin, ASQ Quality Press, USA

-Erick C. Jones, (2014), **Quality Management for Organizations Using Lean Six Sigma Techniques,** CRC Press, Boca Raton, USA:

-Lynne Miller Franco, Jeanne Newman, Gael Murphy, Elizabeth Mariani, (1997). **Achievement quality through problem solving and process improvement**, Quality assurance methodology refinement series, center for human services, USA

- John S. Oakland, (2014), **Total Quality Management and Operational Excellence**, Devon, UK

-Zairi, Mohamed, (1991), **Total quality management for engineers**, Woodhead Publishing Ltd., Cambridge, England

2. Journal article :

-Gerald F. Smith, (April 2000); **Too Many Types Of Quality Problems Categorizing your problems in solution relevant ways** , Quality progress magazine, USA, https://quality-texas.org/wp-content/uploads/2014/11/Quality-process-problems.pdf

3. Internet websites:

- Abdollah Salleh, drdollah.com/quality-improvement/problem-solving/, consulted on 20-01-2019

-Arturo Realyvásquez-Vargas, Karina Cecilia Arredondo-Soto, Teresa Carrillo-Gutiérrez, Gustavo Ravelo, **Applying the Plan-Do-Check-Act (PDCA) Cycle to Reduce the Defects in the Manufacturing Industry**, https://www.researchgate.net/publication/328791833_Applying_the_Plan-Do-Check-Act_PDCA_Cycle_to_Reduce_the_Defects_in_the_Manufacturing_Industry_A_Case_Study, consulted on 03-02-2019

-Jeffrey Henderson, www.bemidjistate.edu/academics/zp-content/uploads/sites/73/2017/03/ The-Quality-Problem-Solving-Method-and-its-Effectiveness-at-Nortech-Inc-Henderson Jeffrey.pdf, consulted on 22-01-2019

- Rai Technology University Campus, **Total Quality Management**, Bangalore, India. https://www.pdfdrive.com/total-quality-management-e57372970.html, consulted on 12-02-2020

-Vi Nguyen, Nam Nguyen, Bastian Schumacher, Thanh Tran, **Practical Application of Plan–Do–Check–Act Cycle for Quality Improvement of Sustainable Packaging: A Case Study, https://www.mdpi.com/2076-3417/10/18/6332**, consulted on 17-10-2020

-https://www.skillsyouneed.com/ips/problem-solving.html, consulted on 10-02-2020

-Web.njit.edu/2lipuma/GPS.htm. consulted on 12-02-2020

- https://werryworkforce.org/quality-improvement/pdsa. consulted on 12-02-2020