Available online at: http://e-jurnal.lppmunsera.org/index.php/JSMI

Jurnal Sistem dan Manajemen Industri

ISSN (Print) 2580-2887 ISSN (Online) 2580-2895

Plan do check action (PDCA) method: literature review and research issues

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ARTICLE INFORMATION

Article history:

Received: April 27, 2020
Revised: June 28, 2020
Accepted: July 24, 2020

Keywords:

Continuous improvement
Deming cycle
Industrial
PDCA
Productivity

A B S T R A C T

The development of the industry that is increasingly making businesses try to be competitive by increasing technical knowledge and improving systems both internally and externally. PDCA is a quality management system that is used as a continuous improvement tool that is widely used in the service and manufacturing sectors. PDCA activities consist of four steps namely Plan, Do, Check, and Action with repeated stages forming like a circle. PDCA is a continuous improvement tool that is widely used in the services and manufacturing sector. The cycle of PDCA begins with small to check possible effects on systems, but then eventually progresses to larger and more specific improvements. The results of the implementation PDCA method can be used to solve the problems of qualitative and quantitative data problems that have been widely applied in the service and manufacturing sectors for continuous improvement and as a work pattern in improving a process or system in an organization and increasing productivity. The method used in this research is the literature review research paper has been published in 2015-2020 that have consistently applied the PDCA cycle. The result of this literature review is to describe the relationship between thinking or gaps in theoretical and practical thinking about the application of the PDCA method and the successful implementation in the service and manufacturing sectors as a contribution to further research.

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1. INTRODUCTION

The development of the industry that is currently significantly increased and makes business people try to continue to improve technical knowledge and improve the system both internally and externally to be competitive. The application of kaizen (continuous improvement to be better than before) can be done by making improvements, such as improvements to the method of making products that are considered less efficient and effective, both in terms of time, cost, and human resources [1]. So we need the principle of process management, as one of the industrial management approaches to improve

http://dx.doi.org/10.30656/jsmi.v4i1.2186

quality and efficiency in services [2], [3]. The principle is the Plan-Do-Check-Act (PDCA) cycle which is a quality management system in the industrial sector such as manufacturing, services, offshore, project areas, organizations, etc., which was popularized by Dr. Edwards Deming, an American quality management expert in the field of 1950. The PDCA method is useful to make continuous improvements without stopping which in principle is more future-oriented, flexible, logical, and reasonable to do and contains a description of all elements of the plan drawn up [4].

This method for controlling and improving the management process supply chain or the company's habits consists of repeating four steps. In other words, there are 4 phases used in this method to pay attention and adjust the deviations that might occur with the main goal of being better in business processes. The PDCA process ends with the Planning, Conducting, Testing, and Implementation steps also known as the Deming Phase. Deming developed the plan do check action cycle as a four-stage repetitive problem solving [5]:

1. **Plan** - Plan consists of setting goals and processes to achieve specific results.
2. **Do** - This step was previously created.
3. **Check** - The inspection process stages have been monitored and evaluated according to specifications
4. **Action** - In the fourth step, actions are taken to improve results and meet or exceed specifications.

In general, PDCAs in the manufacturing industry are applied to reduce waste (waiting time, idle, failure, defects, etc.). However, in this study, a literature review will be conducted to describe the application of PDCA in several sectors other than manufacturing that can also reduce waste, or improve quality, etc., with a quantitative or qualitative research approach. The concept of PDCA cycle produces several actions to correct corrective, temporary, and permanent. Corrective and continuous actions consist of eliminating the root cause. Interim measures to correct and correct problems [6].

PDCA cycle produces several actions to correct corrective, temporary, and permanent. Corrective and permanent actions consist of eliminating the root cause. Temporary measures to correct and correct problems. PDCA can provide controlled problem solving for a process by providing added value. PDCA is sufficient under the following conditions [5]:

1. When Kaizen and the sustainable development approach are implemented. Various improvements occurred in the area traversed at the same time resolve existing problems when the PDCA cycle is conducted.
2. A process's carried out repeatedly, will be able to identify new solutions and improvements. In this situation, the benefits gained from more advances implanted in the implementation process that's carried out many times.
3. New solutions can be explored to solve the number of problems and improve solutions while testing with control implementation.
4. Implementation without first testing can avoid wasting large amounts of resources.

Quality is vital to discuss at the company because excellent and effective quality control activities eliminate waste and increase the company's ability to succeed and survive [7]. So, the purpose of this analysis is to evaluate the success trend of the PDCA process, which has a direct impact on market efficiency and productivity.

2. RESEARCH METHODS

The method to be used for this study is the study of literature. The data obtained are compiled, analyzed, and concluded so as to obtain conclusions regarding the study of literature [8]. Research with literature studies is also research and can be categorized as a scientific work because data collection is done by a strategy in the form of a research methodology. An effective and well-conducted review as a research method creates a firm foundation for advancing knowledge and facilitating theory development [9]. The implementation literature review method can compare several journals that use the settlement method with PDCA. Comparisons of several journals have been carried out to find common objects, methods, and problem-solving. In addition, this can highlight the features of the PDCA method. The method used is to review the 2015-2020 research papers that consistently apply the PDCA cycle and have been published. Using the 2015-2020 research paper, to find out the development of the PDCA method in recent years and also the level of success after applying the PDCA method. The implementation literature

review method can compare between several journals that use the settlement method with PDCA. A comparison of several journals has been carried out to find object similarities, methods, and problem-solving. Moreover, it can highlight the features of the PDCA method. The method used is to review the 2015-2020 research papers that have consistently applied the PDCA cycle and have been published. Using the 2015-2020 research papers, in order to know the development of the PDCA method in recent years and also the level of success after applying the PDCA method. The journals can be classified according to year of published (Fig. 1) :

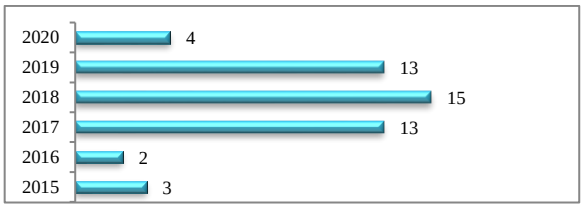

Fig 1. Year of published

The research method is shown in Fig. 2. Within this article, the method contains ten main methods for undertaking a comprehensive analysis of literature, which are:

1. Purpose and objective of research: the purpose and objectives are clearly identified following a review of the most common gaps in the literature.
2. Establish analysis protocol: the protocol encompasses the nature of the sample, the technique, the requirements, the quality assurance, and the retrieval of data, and so on. This approach should be observed during a thorough analysis of the literature.
3. Create validity standards: review guidelines aim to ensure that only the papers most applicable to the study topic are included and that irrelevant papers are omitted.
4. Search and recover literature: online work for related publications in top scientific and professional papers, and hand analysis in bibliography databases, if applicable.
5. Variety of studies: depending on the test requirements.
6. Quality assurance for specific studies: usage of effective quality evaluation methods. The content of each report will be measured according to the methods used.
7. Information extraction: collect the appropriate details from each of the experiments used in the study.
8. Integration of research (study): the usage of suitable methods, such as quantitative or qualitative analysis, or the variation of the derived data.
9. Reporting: commenting in-depth on the systematic examination of literature as well as the findings of the study.
10. Dissemination: publication of systematic analysis in a scholarly journal to add to the information in the area.

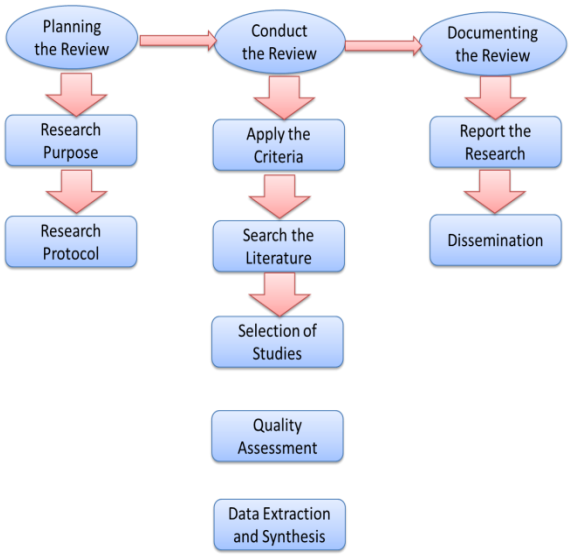

Fig 2. Study framework

3. RESULTS AND DISCUSSION

A literature review is a useful disciplinary activity to provide an overview of a particular problem or research problem by evaluating the state of knowledge about a particular topic. In this case, the literature review was developed by analyzing the research literature published in 2015-2020 relating to the PDCA method (Table 1). Under the right conditions, all of these classifications can greatly assist certain research. However, please note that there are many other forms of literature review, and elements of the approach are different or combined. This is because the approach taken is quite extensive, and needs to be further adapted for certain research. In the following, the basic steps and important choices involved in conducting a literature review will be suggested and discussed using four phases; (1) designing reviews, (2) conducting reviews, (3) analyzing and (4) writing reviews [8].

http://dx.doi.org/10.30656/jsmi.v4i1.2186

Table 1. Existing literature review of PDCA

Research approach	Research object	No. of research object	No. of references	Sum of references	%
A. *Quantitative*					
Reduce					
	Defect / Reject	[10], [11], [12], [13], [14], [15], [16], [17]	8		16
	Losses	[18], [19]	2		4
	Engine Failure	[20], [21]	2		4
	Energy consumption	[22], [23]	2		4
	Lead Time	[24], [25], [26]	3		6
	CLI	[27]	1		2
	Idle Time	[25]	1		2
Increase				50	
	Quality	[28], [29], [30]	3		6
	Durability	[5]	1		2
B. *Qualitative*					
	Qualitative Analysis	[31], [32], [33], [34], [35], [36], [37], [38], [39], [40], [41], [42], [43], [44], [45], [46], [47], [48], [49], [50], [51], [52], [53], [54], [55], [56], [57]	27		54

This literature review collects quantitative and qualitative research. In several papers using primary data and secondary data. Background papers made as a literature review are mostly from the industrial sector. In addition, most of the benefits of implementing the PDCA cycle are aimed at reducing defects and improving quality. The literature review process in this study combines published and relevant literature meta-analyses to provide some evidence of the effect of the existence of the implementation of the PDCA method with several classifications. The classification includes the growth of research publications in the manufacturing sector and other sectors.

3.1 Growth of PDCA cycle publications in the manufacturing sector

PDCA is usually applied in the manufacturing sector, following some research that is applied in the manufacturing sector. The PDCA approach can also be used to reduce the level of defects or the number of defects as a result of research reducing defects in sarong products by the PDCA method showed the largest percentage of defects dominated by filling bars was 12373 or 1.25% in December 2016 [10]. Applies the repair process using PDCA, the results of the study showed a reduction in the number of epoxy defect insufficient from 9994 to 363 units in July 2016 [11]. Improvement activities, defect fender bump LH impact fitting from April-September 2017 can be reduced from 294 defects to 4 defects in December 2017 [12]. After being implemented with the PDCA method the rate of caplet disability decreased from the previous 0.085 DPU to 0.030 DPU, this shows that the quality of the XX Caplet strip increased with a decrease in defects as much as 0.055 DPU [13].

Minimize the defect in the engraving of electronic boards by applying the PDCA cycle and Defective production decreased by 65%, 79% and 77% in the three product models analyzed [14]. Reduced the prevailing defect rate in the car battery manufacturing phase, the PDCA cycle

solution was able to minimize the defect rate by 1.60%, 52% or 0.08% higher that is the goal set by the business [15]. Reduces blade component errors from 9.58% to 2.76% of inputs, equal to 6.82% of inputs [16]. The number of losses from defects in wood flooring products decreased by Rp. 185,500,000 and the number of losses from defects in wood panel wall products decreased by Rp. 210,000,000 [17].

3.2 Growth of PDCA cycle publications for increase quality and durability

The PDCA approach can also solve quality issues, can increase the level of hand hygiene in hospitals by 60% [28]. Shows a decrease in the defect milk laboratories from the beginning of 368 to 85. In contrast, the Power Index (CP) rose from 0.52 to 1.07. The decline in the number of contaminated milk samples 6.04% and the rise in CP raises production 7.90 % [29]. Other quality problems are shown when the Deming cycle steps are applied, reduces the number of quality problems during the photo frame production process, a reduction of more than 60% is observed [30].

Reduce the problem on the life of the brake plate, after testing the brake looks to last longer, result from testing: reducing 75% of problems related to braking, Reducing the expense of the warranty for the company, happy buyers, the prestige of the product is gained, the protection of the issue is minimized by the brake [5].

3.3 Growth of PDCA cycle publications at another sector

By developing and evaluating the incorporation of the conceptual model of takt planning and the Deming cycle in an offshore construction environment can reduce lead time by 28% [24]. In comparison, PDCA cycle can reduce the lead time of the handover process in the PT ABC warehouse by 77% [26]. Another case which implements warehouse management using the PDCA method in CV Innotect Solution from its research results can reduce idle time by 78% [25]. With the theme of energy, proposes a renewable energy installation plan for rural communities in Africa with the PDCA method and has given results that can reduce the use of renewable energy 2.45 kWh/year [22]. In contrast, reduce the use of energy consumption in small industries using the PDCA cycle can reduce 35% of energy consumption [23]. Themed machine research with the application of the PDCA method, the level of damage to the saline machine decreased after repairing the engine Speed and Air Flow Damper damage by 45.6% of the total damage [21]. Minimize the reject start on the extruder machine 100% at PT Wahana Duta Rucika [20].

The PDCA method can also be used to reduce losses after an improvement in oil losses in the boiled water previously 1.06% decreased to 0.9%, meaning that the initial oil loss of 1.75 Tons/day to 1.12 Tons/day [18]. The suggested introduction of a target change pillar to minimize the potential value of pygas commodity failure with the application of the PDCA process will result in a possible failure value reduction of $2,536,018.5 [19]. Another issue that can be solved by the PDCA approach is the reduction of the Cans Loss Index (CLI). During the second year, CLI reached a goal of 0.60% and expenditure decreased by 28.91% at the beginning of four months [27]. Basically the application of the PDCA method has been widely used, in addition to the journal descriptions mentioned earlier in Table 1, there are still many other journals that use qualitative data to implement the results

Based on the paper reviewed, the benefits of successful implementation of the PDCA cycle in the manufacturing sector from the most journals to the fewest (Fig. 3):

1. Qualitative Analysis
2. Reduce Defect
3. Reduce Losses
4. Reduce Engine Failure
5. Reduce Energy Consumption
6. Reduce Lead Time
7. Increase Quality
8. Increase Durability
9. Reduce CLI
10. Reduce Idle Time

Based on the data in Table 1. information is generated that applying the PDCA method can result in the elimination of waste in the workplace (reducing lead time, idle time, energy consumption, machine failure, losses, defects, etc.) and increasing productivity and improving quality. In applying the PDCA method, commitment is needed because the PDCA method implements a cycle process which means Plan, Do, Check, and Action must be carried out continuously. 10 classifications have been explained which are the dimensions of the research variable (Fig. 3) and Fig 4 explains the

http://dx.doi.org/10.30656/jsmi.v4i1.2186

small scope of the research variable. The result of the research variable can be assumed that the lack of trends in the manufacturing sector has resulted in a real calculation of the success rate of using the PDCA cycle. More researchers use the PDCA cycle for qualitative research. While qualitative research is less able to show the success rate of implementation of the PDCA cycle applied. There is a need for further research to update the method used to be able to demonstrate the degree of success of its implementation.

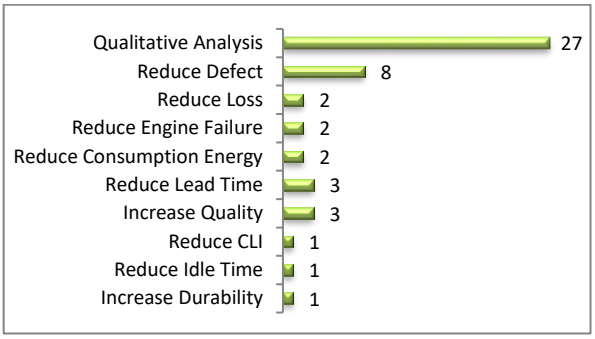

Fig. 3. Dimensions of the research variable

Fig. 4. The research result and variables

4. CONCLUSION

There is an essential role in research by conducting literature reviews such as in the "Plan Do Check Action (PDCA) method: Literature Review and Research Issues" from the results of research literature that have been published from 2015 - 2020 is this research is useful as a basis for developing knowledge, gaps in views, providing evidence of effects, and if done well, has the capacity to be applied as further research ideas. An objective application of the PDCA method can result in the elimination of waste in the workplace (reducing waiting time, idle time, energy consumption, engine damage, loss, defects, etc.) and increasing productivity and improving. Subjective application of the PDCA method requires high process commitment because the PDCA method implements a cyclical process which means that the Plan, Perform, Check, and Action must be carried out continuously.

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