Common Mistakes in Running PDCA: A Survey on University Student PDCA Projects

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Abstract. The main purpose of this paper is to present common mistakes in running Plan-Do-Check-Act (PDCA) project by using case study. New practitioners with petite knowledge are having a high tendency to perform simple mistakes in conducting PDCA project. The study focused on the projects conducted by Universiti Sains Malaysia (USM) manufacturing students as approaches. The mistakes are collected during the project presentation and finalized by the Lean Six Sigma (LLS) experts. A questionnaire survey was sent to LSS experts to rate the high impact mistakes according to their experiences and knowledge. In total, there are 12 mistakes listed overall to all PDCA phases. Five mistakes are highlighted as high impact mistakes according to 80-20 rules of Pareto. The findings emphasize some ideas that might help new practitioner to avoid such mistakes. However, the case study presented only focus on the mistakes in project conducted by university students not a practitioner in industries.

Keywords: PDCA, Lean Six Sigma, Problem solving, High impact mistakes

1. Introduction

Lean Six Sigma (LSS) is a widely-accepted methodology for continuous improvement [1-3]. Normally, a mature LSS organization would deploy a structured training scheme to impart relevant knowledge to its staff. An example would be a four-level certification system, starting from Yellow Belt (YB) and gradually proceeds to Green Belt, Black Belt and Master Black Belt [4]. Each level would have the staff acquires different LSS methods and tools which increase in complexity. It is also a norm for the staff to go through a practical session, e.g. leading and direct involving an improvement project. For example, in YB level, participant familiarizes with PDCA. PDCA is one of the fundamental and methodological tools introduced in the structured training scheme. It divides an improvement project into stages of deployment and defines steps to facilitate the project running. According to Sokovic [5] and Eirin et al. [6], the success of PDCA heavily relies on the support of management and the knowledge about how to use the method, when to apply, efficient performance and activities which can help to focus on the topic.

Similar to PDCA, Kaizen is also known as a continuous improvement which is a process of changing thing towards better. A common structure of Kaizen is based on four different stage of PDCA namely: PLAN – detain planning, DO – implementation of works, CHECK – measure the changes and ACT – refine the improvement [7-8]. In relating to this research, previous researchers has discussed about the common mistakes in executing Kaizen such as lacking a charter, unable to identify critical success factors, having too large scope, not function team members, less supports from top management and etc. Some of the mistakes listed are related to this research output where the mistakes also made by
participant while conducting their PDCA project. According to Emiliani [9], the lack of involvement from the executives in performing Kaizen lead to the failure of a project. The issue is then highlighted as one of the challenge in executing kaizen [10]. By not seeing waste, unevenness, and unreasonableness, first-hand, they are not going to believe it hence, not giving supports to the project executed.

The next section briefly reviews PDCA cycle. Section three outlines the case study and methodology. Section four lists down the pitfalls made by participants in undertakings of PDCA followed by the discussion. Lastly, the conclusion will be made in section five.

2. PDCA Cycle
PDCA cycle is a method used to coordinate a continuous improvement project. The evolution of PDCA is summarized in Figure 1. It was originated from Walter Shewhart (Shewhart Cycle) and later popularized by Edward Deming (Deming Wheel) [2]. Deming wheel constantly iterates four phases namely design, production, sales and research, with quality and service [11]. Deming Wheel was gradually replaced by PDCA cycle due to similarity [12] and preference. PDCA cycle is not only prevalent in manufacturing industries but also in other fields such as medical [13], agriculture [14] and service [15].

![Figure 1. Evolution of PDCA](image)

PDCA cycle helps practitioner to carry out improvement systematically. It leads the improvement towards the direction of preventing error recurrence by establishing standards and continuing standardization [11]. In “Plan” phase, the goal statement are clearly stated to highlight the main purpose of the project. By addressing the grasp of current condition, the practitioner able to obtain the understanding of the present working method and environment. Setting the target condition for a project describes a desire future state of which the project would be resolved adequately. In determining the root cause of the problem, practitioner might apply several LSS tools such as cause and effect diagram, 5-WHY analysis, and Value Stream Mapping (VSM) to conduct the root cause analysis. The suitable countermeasures are selected via relevant LSS tools such as prioritization matrix, FMEA, and Poka-Yoke. “Do” phase covers the process implementation of selected countermeasures. Naturally, it takes a comparatively longer time, partially due to the pilot run or test before full implementation. “Check” phase involves the monitoring and reflection of the improvement to detect any possible refinement. The results of before and after implementation are compared in an appropriate visual or graphical analysis. To sustain the project improvement, “Act” phase plays the important role among all the phases. Project standardization and monitoring after implement the countermeasure to keep the assurance to the workers in following the implementation made. Upon the project closure, practitioners are encouraged to perform Yokoten which is to share the experiences and knowledge gained throughout the project to other related department. PDCA cycle repeats until the goal is achieved. It is not unusual that PDCA go through several iterations before the goal is achieved [6].
3. Case study and methodology
This section outlines the case study and research approach. PDCA projects of practitioner from fifth batch of YB training program were studied. They have completed the training prior to the project. These projects related to the improvement conducted in industries. Twelve PDCA projects each runs with a group of two participants and takes place at different industries including packaging industries, food industries, paper industries, groceries store and etc. One mentor from academic field are assigned to assist three groups. The completed project duration is around 10-12 weeks.

The project’s outcomes were presented to LSS experts from various levels of LSS and the mistakes are identified through the project presentation. A questionnaire developed to rate the mistakes which can cause high impact to the successful of a project. The questionnaire was distributed and filled by ten LSS practitioners in industries and academic field. An interview session was conducted to rank the mistakes, obtain justifications and suggestions to avoid the high impact mistakes.

4. Results and discussion
Twelve mistakes (Table 1) were gathered during the project presentation. Eight mistakes are identified in Plan phase (66.67%), one mistake each in Do and Check phases (8.33%), and two mistakes in Act phase (16.67%). Plan phase is most decision intensive where the path of the project is determined.

4.1. List of mistakes from PDCA project conducted by USM students

| Phase  | No | Mistakes                                                                 |
|--------|----|--------------------------------------------------------------------------|
| PLAN   | M1 | Did not provide a specific, measurable, attainable, relevant and time bound (SMART) goal. |
|        | M2 | Poor study on current condition.                                           |

Figure 2. PDCA Cycle [5-6]
4.2. High impact mistakes

From the survey result, M6 has been rated as the highest impact mistake. According to the Pareto chart shown in Figure 3, five mistakes occupy 80% of the votes.

![Pareto Chart](image)

**Figure 3.** 80/20 rule of Pareto chart voted by respondent

The first high impact mistake highlight is improper use of LSS tools in “Plan” phase. Improper use of LSS tools means the tools is applied in inappropriate way and not used thoroughly. For example, the practitioner applied cause and effect diagram to identify the root cause but the critical root cause is not specified. Failing to do so potentially leads to undertaking of wrong countermeasure and hence poor attainment of goal. This might be because of the lack of understanding on the use of LSS tools among...
the practitioners. Nordin et.al [14] states that the lack of understanding the LSS tools is a main barrier for a successful improvement project. Improper use of LSS tools also occurred when multiple similar tools applied especially in identifying root cause. One of the group identify the root cause on the high replacement order in packaging factory using both 5-WHY analysis as well as cause and effect diagram. In 5-WHY analysis, the root cause founded are corrugated cutting operation, paper debris not cleaned regularly and inspection work after finishing not carried out all the time. However, a different set of the root causes were listed in cause and effect diagram. This leads to confusion; hence additional step of screening is required.

The second high impact mistake is no evidence on process standardization after the implementation in “Act” phase. Practitioner run the countermeasures in project improvement without notify the workers regarding the improvement made. Practitioners are required to establish a standard work such as Work instruction (WI), Standard Operating Procedure (SOP), Leader Standard Work (LSW) and Visual Management in their project for standardization purpose. However, the documentation work unable to be prepared due to no evidence in process standardization while conducting the project. Fundamentally, process standardization boosts workers quality and productivity while reducing ambiguity in executing task. In the findings, 25% of the groups did not provide evidence on process standardization; SOP and LSW. In one of the PDCA projects, creating a standard way to load carton is listed as the countermeasure but no SOP provided. Apart from that, another one group added steps in manual sealing process but no SOP was established to acknowledge the changes. Consequently, the worker would not be able to capture the altered steps and tend to turn to the original practices.

The third mistake is practitioner unable to properly define and make explicit to the project difficulties such as obstacles and problems faced in “Plan” phase. Practitioner only specified the difficulties in general such as the environment is not good without unambiguously state details condition of the environment faced. Able to anticipate, define and acknowledge the obstacles help to produce a better improvement plan. By making them explicit to the stakeholders, certain obstacles could be discussed, addressed and resolved at the early stage, so that they are not becoming hindrances during the project deployment. To illustrate the point in other view, a process improvement project in a contract manufacturer plant needs customer approval. In addition, products from the pilot run needs verification by the customer. With such aspect not acknowledging as an obstacle, the progress of the project suffered two weeks delay.

The fourth mistake is the erroneous of data collection in “Plan” phase. The mistake occurs when the data collected contradict with the goal statement. Practitioner may not clearly understand the project goal thus lead to collect wrong data. The information from the workers are not sensible to be use as data collected. It is essential to collect the actual and correct data by our own because data collection aids in decision making process, changes or pursuing a particular course or action [17]. In one of the projects, the data presented is not accurate when the total time consumed for the task of loading carton in lorry not include the entire task such as loading and unloading carton from trolley. Wrong data collection able to cause the project deviated from its direction and the goal unable to accomplish.

The fifth mistake is wrong application of tools during implementation in “Do” phase. As mentioned earlier, various LSS tools applicable in implementing the countermeasures such as visual management, experimentation, and four-steps training. The availability of many compatible tools promoted in different literature worsens the situation, especially for novice practitioner [18]. In this case, to acquire a decent knowledge transfer, the practitioner required to choose the suitable LSS tools to run the implementation. According to James and Pavnaskar [19, 20], misunderstanding of the tools uses can causes the misapplication of LSS tools. For instance, one of the countermeasures listed in a project is four steps training for newly joined worker to familiarize them with the process. However, only one to two times training conducted thus, it shows that the practitioner not applied the correct application of four steps training. As a result of unable to apply the LSS tools correctly, the purpose of the improvement will not be achieved.
Suggestion to avoid high impact mistakes

In conjunction with the high impact mistakes, the author and team has come out with the suggestions to avoid them. The mistakes can be prevented by having a frequent Gemba walk, attending more specific training especially on interrelationship of tools, close mentorship especially for novice practitioner, goal alignment upon completion of the key steps, checklist of good practices or mistake avoidance and progress meeting. The suggestions are explained in details below and may be effective for several mistakes.

Frequent Gemba walk is suggested for practitioner to gain direct exposure to the situation. In LSS principle, Gemba walk is refer to the visit at real place where improvement will be conducted. Practitioner will gained valuable insight into the value stream in the particular process based on their own observation rather than relying on others. It take place on a regularly schedule basis, usually at one week intervals [21]. A structured plan is required before starts Gemba walk in order to collect correct data. The planning should include few aspects such as what, how, when and where to collect the data. According to John [22], the data collection consist of two different purpose and stage which are, collecting the data before and after improvement for comparison purpose. Practitioner also encouraged to documenting the observations made during Gemba walk by recording and jot down the task carried out by workers. If the camera is not allowed in the workplace, sketching on a piece of paper would be helpful. Other than planning and documentation, mix up schedule for Gemba walk also helps the practitioner to get a complete sense of what happens in the particular process with the different workers nature at different time. Eventually, M5 can be avoided with the frequent Gemba walk with a truthful data gathered.

Practitioners are suggested to attend specific training for LSS tools before conducting a PDCA project. Mistakes involving the application of LSS tool (M6 and M9) can be avoided through the provision of suitable and topical training especially on interrelationship of LSS tools. By attending the training, practitioners will have an idea in deciding the appropriate tools to be use in their project. Improper use and wrong application of the LSS tools shows the lack of knowledge among the practitioners. Knowledge and information about LSS tools uses is necessary due too high number of tools available. Langlay [23] said, educational actions are highly emphasize in order to get knowledge about the method so that practitioner are able to perform continuous improvement initiative based on PDCA. This is supported by Yan and Makinde [24] where the management must prioritize training opportunities to all in assuring the level of understanding on LSS tools usage. There are several type of LSS tools training available including online and offline training. However, the training attended should consist the details on lists, uses, and how to apply the LSS tools in a project.

The third suggestion to avoid mistakes in PDCA project is to have a close mentorship especially for novice practitioner. Mentorship in the context of this research is a person who is an expert in LSS will guide the new practitioner throughout their PDCA project. Close mentorship means the practitioner must having a regular face-to-face meeting in a sustained period of time with the mentor. The encouragement and guidance from a mentor in planning, running experiment and making decision for the duration of conducting project helps new practitioner. It is require for them to have a close mentorship moreover further intensive mentoring would be preferable to assist them in project deployment. In addition to the tool options, mentoring also helps to make decision to choose the key obstacles as well as in outlining the data needed in the project. All mistakes listed in high impact mistakes can be avoid by having a close mentorship except for M11. However, the compatibility between mentor and practitioner is vital for a successful mentorship [25].

The fourth suggestion is to make a goal alignment upon completion of the key steps. Goal alignment is the process of aligning the work with the appropriate determination after went through few process. The aforementioned goal is to keep the practitioner to work towards the main goal and guide for collecting data. It is significant to specify the goal statement prior data collecting. This is supported by Grace and John in their research work [26]. In order to align the goal statement, practitioners are suggested to present the obstacles and difficulties faced in the project to the team members. When the
people understand what the constraint are, they can helps to define it clearly and suggest on how they align with the goals of their project. By having discussion about this issues, M4 and M5 can be avoided. Without the goal alignment, it is impossible for the practitioner to gather correct data and properly define the obstacle.

Creating a checklist of a good practices or mistake avoidance is the fifth suggestion to avoid mistake in PDCA project especially M11. Good practice checklist is a list to decrease failure by compensating the limitations of human memory and attention. Checklist is necessary in project improvement due to several countermeasures made in the meantime. Providing checklist to the workers able to sustain the improvement made. The main intention is to avoid the negligence in providing the evidence for process standardization. Besides, with the checklist for all improvement conducted, there is no chances for some information to be left behind. A standard will be formally establish in “Check” phase to keep track on the standardization made so that it can help to notify the new workers join the company about the changes. Hence, the practitioners are suggested to provide checklist so that it can be translated into a documented work such as SOP, WI and LSW before the project enclosed.

In avoiding perform high impact mistakes in PDCA project, the progress meeting among the team are necessary. The progress meeting is to update and discuss with the team members on the project development. The effective oversight into an improvement process able to help the goal is well accomplish. With regular progress meeting, team members will be more perceive on the improvement progress and partake for giving ideas in problem solving. All cross-functional members in team able to give ideas for any matter in their area of expertise. The team members should settle into an effective routine after the agendas are produced ahead of time and assignments are conducted between meetings [26]. All mistakes listed in high impact mistakes can be avoided with the aid of progress meeting because of practitioners will become more cautious on the steps of improvement. The progress meeting involving all stakeholders also required to address the obstacles and problems of the project. This method is helpful for the practitioner to explicit the obstacle faced in the improvement project to the top management. Difficulties encountered can be eliminate with the management acknowledgement. Instruction and support from top management are urgently needed especially the difficulties is involving the commitment from the employees, customers and constraint in the financial aspect.

5. Concluding remark
This study shows that “Plan” phase play an important role in PDCA project. Mistakes occurred in in planning the project is more than half of the total mistakes. To avoid all high impact mistakes, a regular progress meeting is advice. However, the lack of knowledge in LSS tools will gave huge impact in an improvement project.

The extensions of this research include the study into the synergy of LSS tools in PDCA project. Each PDCA phase has several suitable LSS tools to be use. By recognizing the LSS tools to each phase, it would be easier for the practitioner to apply them when conducting a project. The PDCA project conducted easily with a deeper explanation on how LSS tools can be used in each phases. The practitioner of YB program acquires their first time experience to conduct project in industries. With the bits of the help of this paper, there is no doubt if the mistakes come from them can be eliminated in the future.

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