'*TPM Green-Belt*': A Comprehensive Development Program for Continuous Improvement Competency of Engineers

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Abstract

Total Productive Maintenance (TPM), one of many well-known continuous improvement programs, has been implemented worldwide as an approach for operational excellence, especially in manufacturing. Being a comprehensive methodology with unique concepts and frameworks, TPM suggests, prepares, and sometimes directs how employees think and behave in a certain way. Consequently, staff development is one of the most important parts of TPM and it is embedded in almost every activity or implementation step. However, besides some explicit suggestions and methods for employee development, most of how staffs are developed to work in TPM way is implicitly ingrained into implementation practices. Thus, this usually leaves an organization to figure-out by itself how to best develop its employees to have desired competency and behaviors.

A company studied in this paper has been implementing TPM as a platform for operational excellence for more than ten years. Along these years, it has tried many approaches for employee development, mainly based on suggestions by consultants from the Japan Institute of Plant Maintenance (JIPM). All the development efforts were considered to be neither truly effective nor totally ineffective. Recently, borrowing ideas from development approach utilized in a typical Six Sigma program, this company developed a comprehensive development program for enhancing its engineers' TPM knowledge, skills, and desired behaviors, called 'TPM Green-belt.'

This paper expects to propose a new approach for employees' development for TPM implementation as an example for other manufacturing organizations, fulfilling the gap that many TPM consultants or training organizations have not focused, so far. We outline how this TPM belts program is developed, starting from getting information about the desired knowledge, skills, and behaviors that the targeted engineers should possess. Then learning solutions, both technical and mindset aspects, which are readily available fragmentarily across the organization, are studied and matched with the learning needs. Lastly, the program is designed with blended learning approach, including classroom training, workshop and learning-kits, and on-the-job-coaching. To conclude, results of the first-batch TPM Green-belt training are presented, to demonstrate how competency (i.e. knowledge and skills) and behaviors of the participating engineer have improved to support the implementation of TPM.

Keywords total productive maintenance, human resource development, training and development, competency, continuous improvement

1. Introduction

Continuous Improvement (CI), as pioneered by Frank Gilbreth and later elaborated further by management gurus such as Edward W. Deming and Japanese practitioners such as Masaaki Imai, emphasizes the need to continuously improve processes or products, using fact-based, long-term, process-oriented and employee-involvement techniques (see e.g. Ahire, Golhar, and Waller, 1996; Flynn, Schroeder, and Sakakibara, 1994). CI has been one of the main focuses of both academic researchers and business practitioners for more than forty years (Boer, Berger, Chapman, and Gertsen, 2000). Even though it originated in America, CI was developed, enhanced, and used very effectively and efficiently by the Japanese (Boer et al., 2000; Robinson and Stern, 1997). Then it came back to the West as one of the most successful exported management techniques (Schroeder and Robinson, 1991).

There exist many practices in order to promote, facilitate, or even carry-on continuous improvement initiatives, and total productive maintenance (TPM) is one of major initiatives (see e.g. Anderson, Rungtusanatham, and Schroeder, 1994; Douglas and Judge Jr, 2001; Flynn et al., 1994; Lillrank et al., 2001; Rungtusanatham, Forza, Filippini, and Anderson, 1998.) A company studied in this study has been implementing TPM as a platform for operational excellence for more than ten years. Along these years, it has tried many approaches for employee development, mainly based on suggestions by consultants from the Japan Institute of Plant Maintenance (JIPM). All the development efforts were considered to be neither truly effective nor totally ineffective, especially the development for engineering level employees. Recently, borrowing ideas from development approach utilized in a typical Six Sigma program, this company developed a comprehensive development program for enhancing its engineers' TPM knowledge, skills, and desired behaviors, called '*TPM Green-belt.*'

As a result, this article aims to propose a new approach for employees' development for TPM implementation as an example for other manufacturing organizations, fulfilling the gap that many TPM consultants or training organizations have not focused, so far. We outline how this TPM belts program is developed, starting from getting information about the desired knowledge, skills, and behaviors that the targeted engineers should possess. Then learning solutions, both technical and mindset aspects, which are readily available fragmentarily across the organization, are studied and matched with the learning needs. Lastly, the program is designed with blended learning approach, including classroom training, workshop and learning-kits, and on-the-job-coaching.

2. People Development, Education, and Training – as Suggested in TPM Program

Table 1 Abilities Most Needed in Operators and Maintenance Staffs, as Recommended by TPM Approach (JIPM-S, 2007)

Ability Most Needed in Operators	Ability Most Needed in Maintenance Staff
Detecting problems	Instructing operators in daily maintenance knowledge & skills
Understanding the structures and functions of their machines	Detecting problems, and identifying real root-cause of the problems
Understanding the relationship between machinery and quality	Increasing the reliability of machines and components
Carrying out repair (at the root-causes)	Increasing equipment maintainability
Doing improvements on topics that affect bottom-line of the organization	Acquiring and applying advanced diagnostic techniques

Total Productive Maintenance (TPM), as defined by the Japan Institute of Plant Maintenance (JIPM) (Shirose, 1996), is a comprehensive approach that addresses four items: (1) goal of maximization of production efficiency (i.e. overall efficiency improvement); (2) focus on prevention rather than

correction, to realizing three zeroes (i.e. accidents, defects and failures); (3) total participation of all functions and personal levels; and (4) achievement of zero losses through overlapping small-group activities. Basically, TPM aims to transform plant's (company's) environment (i.e. machines, equipment and work places) by firstly transforming plant's (company's) workers (Shirose, 1996). Thus developing people is one of the most important aspects of TPM program.

Most of the suggestions and prescription of people development in a TPM package focuses on development of frontline staffs from production and maintenance functions; see Table 1. Moreover, focuses of these people development program are more on technical skills and abilities (e.g. machines maintenance and production processes.) The development is overseen and promoted by a cross functional team (i.e. called *'pillar'*) for *Training and Education*, which can be led by a manager from a core production department or a human resource development department. Some consultants suggest a three-step approach as shown in Figure 1.

Figure 1 The 3-Step Approach for Ability Development as Suggested by a TPM Consultant (JIPM-S, 2007)

As a result, a typical TPM approach lacks completeness in people development in two issues. First, in terms of content, it does not clearly recommend or propose a framework to develop employees' knowledge and abilities for managing people, and mindset for improvement (i.e. non-technical abilities.) Second it does not provide a solid framework to develop other groups of employees, rather than only front-line employees.

In the past, to fulfill this gap, we have asked Japanese experts and consultants to provide this kind of training for our employees, especially the ones who are responsible for promoting and driving TPM program in their functional areas (i.e. so called '*TPM Promoter*.') For example a comprehensive program was organized twice in the past five years. Unfortunately this development program was a 10-consecutive-day, all-lecture, no-follow-up type, thus we could not evaluate and track how effective this training is. Also it is doubtful that this way of training is effective, as some researchers suggest the shortcoming of development program that depends only on a classroom training approach (See, e.g. Lombardo & Eichinger, 1996; Rabin, 2014).

Consequently, we propose an overall framework of people development for TPM promoters and drivers to remove these limitations. To explain this framework in context, let's first examines how we organize people to support TPM implementation as a main approach for operational excellence and CI in our organization.

3. Management of TPM at the Studied Company

In our company, all employees must support and participate in works related to TPM's goals (i.e. improvement of overall plant effectiveness, loss reduction, accidents reduction and prevention, etc.) We also have a dedicated group of staff who oversees development, implementation and monitoring of continuous improvement program, called Quality Management Department. This department is under the division of organizational development and its mission is as show in Figure 2:

> ***MISSION**: Provide professional, effective, and efficient consultation (i.e. including people development, advising, and coaching) for establishment (and integration), improvement and sustainability of the management system, aligning with business directions, and facilitate execution process to achieve business performance excellence and employee satisfaction.*

Figure 2 Mission of the Quality Management (QM) Department

This group of QM staff plays an important role in driving, supporting, and promoting TPM implementation in the organization. Accordingly, we start creating development program for this group of staffs first, and this program will be detailed in this article. (For other group of employees, we will not cover their trainings in this article, since it is s till an on-going plan in our company as well.)

Based on the department's responsibilities (i.e. jobs or tasks), we divide QM staffs into two sub-departments (See Figure 3) according to tasks they have to perform. The first sub-department, called *QM Routine and Operations* is mainly responsible for routine operations and maintenance and continuous improvement of the current quality management initiatives (i.e. ISO 9000 series management system, TQM and TPM). The other sub-department, called *QM Strategic and Center of Expertise*, acts as a center of specialists within the company, in the area of quality management system and tools and techniques for quality improvement. In other word, this is where a pool of quality management subject-mattered experts (SMEs) locates. Moreover, this sub-department also looks for the future – searching for an updated, appropriated quality management approached for the company.

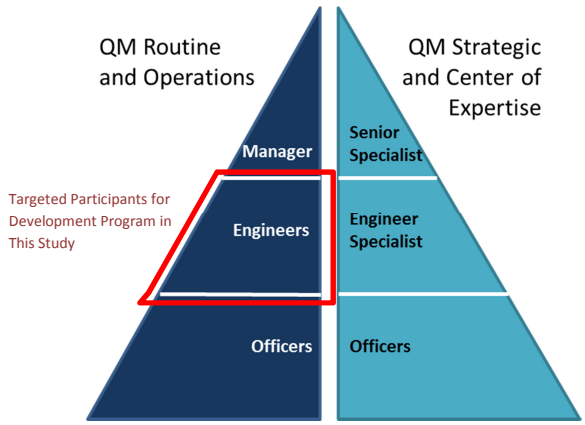

Figure 3 Staff Level at the QM Department

From Figure 2 and 3, we later identified that in order to fulfill the mission, junior QM engineers, for example, have to be able to do all the responsibilities according to P-D-C-A cycle (Tague, 2004), in terms of TPM-related tasks. As examples, responsibilities for *"Do"* phase are:

(1) Identify and explain the process and content of TPM consultation for pillar's management (e.g. pillars' main concepts, and specific approaches and mechanisms.)
(2) Provide consultation for improvement cases (i.e. QCC-group/ individual suggestion level) to achieve desirable result.
(3) Assist and support in trainings and workshops for people development (for both functional and QM) to learn about training process and how-to in order to ensure smoothness (in other words: to avoid problems, such as problems during workshop/ discussion sessions) in training process.
(4) Arrange TPM and bottom-up activities (including system for 5S, QCC Kaizen, and individual suggestions) promotional activities in order to boost-up employee's participations and morale (i.e. through rewards and recognitions.)

4. Development of TPM-Belts Program and the *'TPM Green Belt'*

As stated earlier, our goal is to develop a people development program to serve staff that is not much covered by a typical TPM people development approach. These groups of staff are people who are not directly involve in manufacturing shop-floor or machine maintenance activities, and especially the ones who are at engineering (i.e. supervisory) level or higher. Due to our organizational governance, we chose to focus first on the group of people who is responsible for promoting and helping in TPM implementation, see Figure 3. Later on, we plan to expand this development for all in our company.

From the responsibilities (i.e. required tasks and expected behaviors) that we designed for all of our QM staff, we have the complete framework for development program for all staff, as shown in Figure 4. The framework comprises 4 development programs: yellow/white belt, green belt, black belt, and master black belt. These four programs were designed to match with responsibilities of QM staffs at all levels. However, for the first step, we focused on the "*Green Belt*" level, and it will be shown in detailed in this article later. The main tasks of QM staff at Green Belt level are to be able to (1) counsel section managers and/or supervisors to implement TPM as a tool to increase efficiency of machine and reduce maintenance cost; (2) support Black Belt QMs (junior QM managers and senior QM engineers) to implement TPM in section level; (3) educate TPM tools and techniques for operators and/or frontline staff to enhance capability of people to take care machines; and (4) promote TPM culture in their organization. In the next step, these tasks were used for designing contents and learning approached for this TPM Green Belt program.

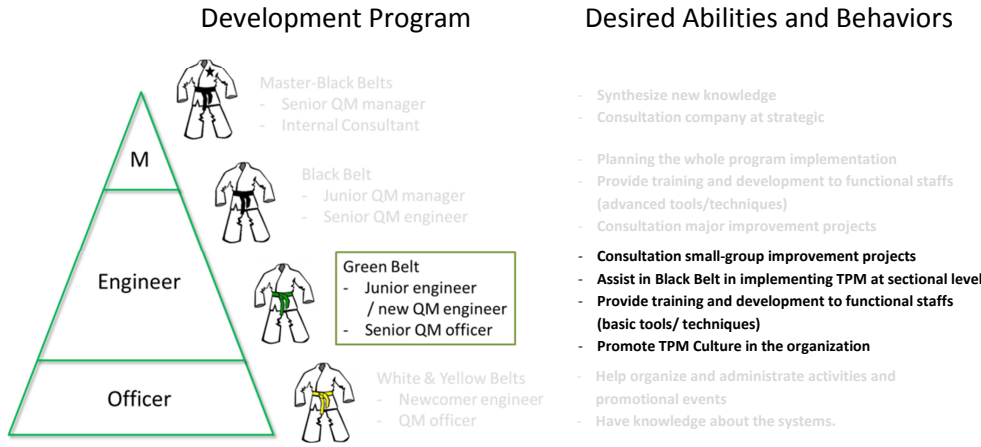

Figure 4 Complete Set of Development Programs for "Management of TPM"

5. Detail of 'TPM Green Belt' Development Program

Table 2 Main Components of the TPM Green Belt Development Program

Program Components	How They Help Satisfying Objective and Desired Outcomes
1. Blended Learning Approach (70:20:10)	Effective way of learning and knowledge and skill development
2. Program Contents	Cover both technical (i.e. hard-side) and management (i.e. soft-side, change management and people management)
3. Individual Consulting Project Assignments	Real project practices and exercises for trial of the lesson learnt in class (i.e. hands-on experiences)
4. Coaching Approach	Enhance learning experience by closely following-up, monitoring, and reflection by SME as coach
5.Other Development Instruments I. Consultation Manual and Checklist II. Learner's Passport and Dialogue	 A handy tool for learners, ready for use on-site - a reminder of minimum requirement to be a good internal consultant. A tool for reflection and dialogue between coach and learners
6. Evaluation and Certification Conditions	Ensuring achievement of knowledge level and certification conditions

To ensure effective learning approach and satisfactory outcomes (i.e. ability to be an internal consultant for TPM implementation and a continuous improvement coach), we design TPM Green Belt development program not solely based on classroom lectures (i.e. as what we had two times before from our external consultant company) but also following a real CI case project as a venue for practices. There are six components that we designed into this development program to guarantee effective and satisfactory results; the six components are show briefly in Table 2. The detail of each item will be described in detail later in this section.

5.1 Blended Learning Approach

Development approach for a learning and development program in our company follows a *"Blended Learning, 70:20:10"* approach (See, e.g. Lombardo & Eichinger, 1996; Rabin, 2014), as show in Figure 5. As such, learning approaches utilized in the TPM Green Belt program comprise classroom lectures, case studies and workshops, site-visit, self-studies, experiences sharing and meeting the SME, and also project assignments. Moreover, other learning enhancement activities are available as well, such as a Community of Practice (CoP) for TPM practitioners is arranged regularly throughout the program, or a forum for experience sharing from both internal and external specialists is organized at least two times per year. Examples of how we applied the learning approaches to each learning topics are shown in Table 3, under *§5.2 Program Contents*.

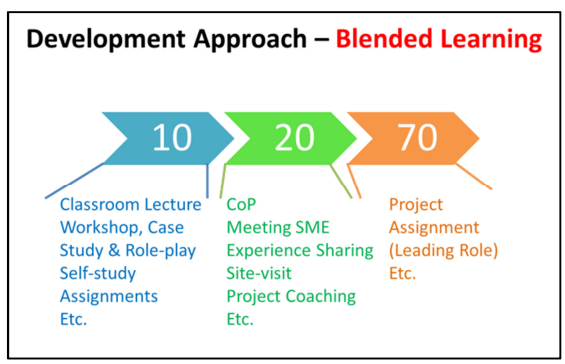

Figure 5 Blended Learning Approach as Used in the Studied Company

5.2 Program Contents

Since the aim of this TPM Green Belt program is to mainly equipment junior QM engineers with knowledge and skills about TPM to be able to be a good internal consultant, the contents of the program consist two major groups of knowledge and skills:

(1) Technical knowledge and skills for TPM implementation and promotion and continuous improvement projects;
(2) Consultation and people management techniques and skills for being effective internal consultant.

For the technical side, we further categorized it into TPM-related topics and QC story-related topics. Table 3 shows the TPM-related topics, duration of class and learning approaches. As shown in the table, most of the learning approaches are classroom lectures by our internal experts in TPM, because a TPM topic by nature is not a technical (or physical) skill-based topic (except Autonomous Maintenance). However, we tried to enhance the learning experience by integrating group discussions, case studies or workshops, and some experience sharing from practitioners into the classes. In addition, homework assignments and self-study are other approaches that we utilized in order to make sure that the learners cover all the details, even though we have not much time in classes or face-to-face meetings.

Table 3 TPM-related Topics in TPM Green Belt Program

TPM-related Topics	**Duration**		**Learning Approaches**									
			Classroom Lecture	Group Discussion	Case Study/ Workshop	Training Kits	Homework Assignments	Project Assignments	Experience Sharing	Meet the SME	Site-visit	Self-study
History & Introduction to TPM implementation of 8 pillars	2	hrs	☺						☺			
TPM Part I, II, III	1	hrs	☺	☺					☺			
Ideas for chronic losses & ideas for zero B.A.D.	1	hrs	☺		☺		☺					
TPM policy setting and deployment	1	hrs	☺	☺	☺		☺		☺	☺		☺
Planning for TPM activities & promotions	1	hrs	☺		☺		☺		☺	☺		☺
EBITDA tree and company performance visual board	2	hrs	☺	☺								
TPM activity report and presentation (for TPM Award assessment)	2	hrs	☺						☺			
(Autonomous Maintenance) Tags, Meeting, One-Point-Lesson, and Activity board	3	hrs	☺		☺	☺			☺		☺	
(Focused Improvement) Loss concepts & structures	3	hrs	☺	☺			☺					
(Focused Improvement) Ideas to improve efficiency	3	hrs	☺		☺		☺					
(Quality Maintenance) Infinite loop approach	3	hrs	☺		☺							☺
(Planned Maintenance) Maintenance techniques and strategies	3	hrs	☺		☺							☺
Other Pillars Mechanisms (Initial Phase Management, Supply Chain Management/ Administrative and Support Departments, Education and Training, Safety, Health, and Environment)	6	hrs	☺									☺
TOTAL	**31**	**hrs**										

As for the QC story for continuous improvement project topics, we aim to equip the learners with required knowledge and skills about tools and techniques for problem solving or running an improvement project. Table 4 shows topics of Tools and Techniques for QC Story and Continuous Improvement Project. It is obvious that even though the entire topic is introduced by classroom approach, they all are further enhanced by workshops or experience-training by using training kits as well. Moreover, tools and techniques that learned in classes or practiced in workshops would be forced to use in later stage of this development program when the learners practice their consulting skills with the real project improvement cases (this will be explained further in *§5.3 Individual Projects and Assignments*.)

Table 4 Topics related to Tools and Techniques for QC Story and Continuous Improvement Projects

Improvement Tools and Techniques Topics	Duration		Learning Approaches									
			Classroom Lecture	Group Discussion	Case Study/ Workshop	Training Kits	Homework Assignments	Project Assignments	Experience Sharing	Meet the SME	Site-visit	Self-study
7 QC Tools, Data Collection and Basic Minitab™	1	Day	☺			☺		☺				
QC Story Approach (Problem Solving and Task Achieving)	2	Days	☺			☺		☺				
Introduction to Statistics for Engineers	3	Days	☺			☺		☺				
P-M Analysis	1	Day	☺			☺						
Autonomation and Karakuri Kaizen	2	Days	☺		☺	☺					☺	
Special topic: Industrial Engineering/ LEAN Techniques	1	Day	☺		☺							☺
Special topic: Roll-paper Analysis (*Makigami*)	1	Day	☺		☺							☺
Special topic: Material-Flow Cost Analysis	2	Days	☺		☺							☺
TOTAL	**13**	**Days**										

For people management and consultation techniques and skills, we tried to construct a curriculum that includes soft-skills for working with people, so that out learners can practice and later use for their project consultation. The soft/ people management skills include following:

- People behavior style (DISC)
- Change management process
- Coaching your clients
- How to deal with difficult situations
- Holistic thinking (Dot-to-Dot Literacy) and critical thinking; Data collection (*e.g.* in-depth interview, facilitating skill) and data analysis
- Building rapport and relationships
- Questioning and active listening skills; Effective communication
- Time management

All of the soft-skill topics above will be trained totally in five days (i.e. three times – 1, 2, and 2 days each.) Most of the learning approaches, again, are mainly based on classroom lectures; however workshops and group discussions are also the complementary approaches, as to make sure that the learners have some sense of how they work in real life situations.

5.3 Individual Consulting Projects and Assignments

To simulate the real working situation - enhancing *'70'* part of the blended learning approach, we ask the learners to be consultants for improvement cases that were going on in their organization. Two goals are involved here. First, and most important, this project assignment, at that time, will be a venue, with real problem, real situation and real people, etc., for the learners to work on, and practice what they have learnt in classes. Second, if success, this project assignment will be one of the evidence of our learners' capability as an internal consultant, creating credibility and clout of success for them.

This CI project would be implemented parallel to the training classes. The learners have to apply what they gain in classes and workshops to help their peers (i.e. internal customers) to solve their peers' real problems or improve conditions, following core consultation step (explained further in detail in

§5.5-II. Consultation Manual and Checklist.) As such, we tried to help the learners select cases that have high possibility for success, thus satisfying this development program's objectives, utilizing the following criteria shown in Table 5. Additionally, we also asked the learners to prepare more than one practice projects, in order to minimize the risk of failure (i.e. by introducing a spare project) and ensure that they have projects to practices for all consultation steps.

Table 5 Project Selection Criteria for Learners' Practice Projects

	Criteria	Objectives
Difficulty Level	• It has to be a small group/ operator level.	• To ensure that level of technical difficulty is not too high.
	• Have a certain complexity, so many opportunities to apply tools and techniques.	• To ensure that the learners have opportunities to try as many tools and techniques.
	• Projects can be done within 6-8 months.	• To ensure that level of technical difficulty is not too high. • To ensure that the learners can finish all the work within the development time-frame.
Progress	• As of the beginning of the development program, progress of the project should not be later than observation stage.	• To provide a venue and practice opportunities of all stages in problem solving QC story.
Readiness	• Have clear team member - roles & responsibilities, and readiness to work on a project (i.e. attitude towards work improvement and experience with CI projects.)	• To minimize possible 'soft' issues (i.e. people difficulties)
	• Projects are approved by both Line Mgr. and QM Mgr.	• To minimize possible 'soft' issues (i.e. people difficulties)
Impact	• Have major impact (i.e. savings, work environment improvement, etc.) as an improvement project.	• To deliver real improvement to the organization the same time as it is a practice job. • To be a good success case in learners' portfolio

5.4 Coaching Approach

To enhance learning experience, we assign our SMEs to be coaches for all the learners. This is a closely following-up, monitoring, and reflection processes by coaches that help the learners to reflect on what they have practiced on-site and in the field. For this TPM Green Belt program we classify coaching into four levels, as shown in Table 6, below.

Table 6 Coaching Approach Utilized in TPM Green Belt Program

Coaching Approach	Coach's Responsibility	Learner's Responsibility
Shadowing	100%	0% (only observe to reflect)
Co-consultation	50%	50%
Learner-Lead	20%	80%
Coach Follow-up	5%	95%

First, '*shadowing'*, the role for the learner is to observe and notice what her/his coach doing during the consultation session. This technique is utilized in the beginning of the consultation practice (i.e. in the beginning of the program) or when consultation involves advanced topics that are new to the learners. Its aim is to provide an example to the learners to reflect on – fulfilling the objective of 'learning from others'. After that, for the topics that a learner is already familiar with at some extent or after some times after learner gains more confident and would like to try to practice what he/she got from classes and workshops, the coaching approach would turn to a '*co-consulting*' practice. For this approach, we would like to provide more opportunity for learners to practice, but under close supervision. Also, for some contents or skills that the learner still lacks, the coach would step-up and assume the responsibility temporarily. This coaching approach will continue until the learner is confident about his/her abilities to take on more responsibility.

Third approach is *'learner-lead'* consulting. At this stage, the learner should learn and therefore master almost all of the required knowledge and skills for solving a problem or doing CI, thus be able to act on his/her-own, with minimum supervision. Therefore most of the consulting activity at this stage is handed back to the learner. A coach is now the one who observes, most of the time, to reflect

on how the learner performs. However, in some situations (e.g. when technical content turns deeper or harder or some difficult situations with managing people) the coach will get involved as extra hands to help alleviate the situation. Lastly, when the learner is ready to solely stand on his/her own legs, all the consultation are done by the learner, even when facing with difficulties and unexpected events the learner have to solve it themselves. The coach only observes how learners perform the tasks and reflects on it. This last phase of practices will enhance the learners to use all their potential in situational management, their knowledge and skills gained from the program, and how to adapt to the real world circumstances.

By all these approaches of coaching, transferring responsibility little-by-little from coaches to learners as the progress of practiced projects go on, we provide step-by-step, systematic real-life setting for the learners to practice on. In addition, we saw that the learners were getting better along the way their projects progress, by the time project finished, the learners also gained all the required knowledge and skills, and already practiced on them and saw the result of their efforts.

5.5 Other Instruments

To provide support for learning process, and later working process after graduation, we prepare two instruments for learners and coaches to utilize as following:

I. *Learner's Passport and Dialogue*
Learner's passport is an individual personal record of a learner's learning process. It records detail of how a learner performs, learns, and reflects in each development session. During a practice (i.e. project consultation) session, the coach will record what he/she observes into the learner's passport in terms of both technical and soft skills. Moreover, the learners will record his/her reflections on what he/she observes when his/her coach advises and lesson-learnt and reflections when he/she performs the practice tasks. These records will be used for a one-on-one (i.e. between coach and learner) reflective dialogue after the session ends, and later a group dialogue (i.e. meeting of CoP.) A visual explanation of the process using this passport is shown in Figure 6.

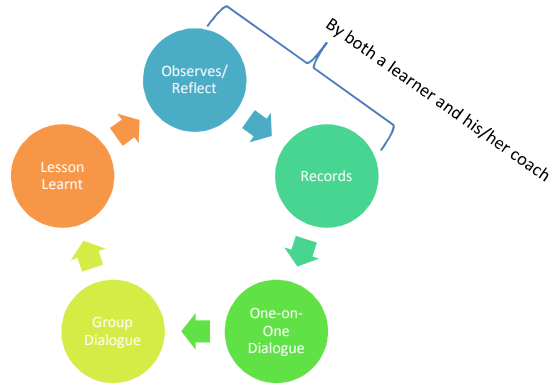

Figure 6 Learner's Passport and Reflective Dialogue Process

These dialogues, as suggested by Isaccs (1999), are "*'conversations with a center, not sides,' a way of taking energy of our differences and taking it toward something that has never been created before… The intention of dialogue is to reach new understanding and, in doing so, to form a totally new basis from which to think and act.*" As a result we see that these dialogues can help not only all the learners but also the coaches themselves to

get better on working together in terms of both technical advancement and people management skills improvement.

II. Consultation Manual and Checklist

We developed an internal consultation manual for using within our organization. This manual is developed based on our internal consultant's practices and experiences. And we standardized it to be a guideline for future consultants to use, with objectives to provide basis of items that a good consultant has to possess. Complementary with the manual, there are also checklists for each consultation steps. These will be a good reminder and tools for our future consultant to have in hands, prompting them to cover all of the important (i.e. minimum, must-have, or 'at least') issues when performing consultant tasks. An excerpt from the consultant manual is shown in Figure 7, below

STEP	Internal Consultation Process	Checklists
1	แนะนำตัว, สร้างความเข้าใจ และเป้าหมายร่วมกัน (Introduction of the consultant, getting rapport, clear understanding, align goals and objectives)	(1) Introduce your stength (2) Introduce your experience (3) Ask what is team's objectives (4) Ask what is team's expectations (e.g. resource aspects) (5) Explain your objectives (6) Explain
2	วิเคราะห์ข้อมูลเบื้องต้น (ทั้งทางด้าน hard & soft) และ วิเคราะห์ผู้มีส่วนได้ส่วนเสีย (Initial data analysis, both technical and soft - change mgt. (incl. stake holder analysis)	(3) Participate in data collection (if possible) (4) Go & See (Genba) (5) Study relevant theory/ principles available elsewhere (e.g. Google, or textbook) (6) Study influential to project success
6	สรุปผลการดำเนินงาน (Summarize and conclude, record lesson learnt)	(3) Identify future opportunities (4) Record best practices and lesson-learnt

Figure 7 Internal Consultation Process Manual with Required Checklists

5.6 Evaluation and Certification Conditions

To ensure quality of staff that passes this development program, we establish criteria for graduation and certifications. Each graduation elements are designed to assure quality of passing learners. First, class attendance and participation evaluates process of learning, i.e. how a learner pay attention to attend classes and when he/she is in a class how he/she show eagerness to learn and share. This element accounts for 20 percent toward the total score. Second element is homework assignments. For some classes or lectures, instructors will prepare assignments for learners to work on during the time they are away from a classroom (i.e. as known commonly in formal education context as *student's homework*.) For example, in a TPM policy generation and deployment class, the instructor ask learners to go back, study their company's current TPM policies and how they were deployed down to pillars' levels, and finally, compare to the business situations at the time of policy creation, analyze and propose improvements to other learners and SMEs the next time the class meet. This element is 20% of the total graduation score.

Third, a paper test was utilized in order to test knowledge of some topics. We use a paper test for topics that traditionally can be tested by this type; for example, statistics, and some other principles and steps in Autonomous Maintenance implementation. The paper test accounts for other 10% towards the total graduation score. Finally, the biggest chunk of graduation score, 50%, is allocated to the consultation projects. This will be evaluated by the coach of each learner, by observation of the coach, together with the learners' passport and, if any, consultation records in the passport. This evaluation aims to assess a learner's both in terms of processes and results, meaning that both how a learner performs during consultation practices and final results (i.e. tangible effects) of the improvement.

For certification, a learner has to get at least 75% of the total evaluation score. In addition, for each sub-element of evaluation, he/she has to get at least 50%. The elements and its passing sub-score are summarized and shown in the Table 7.

Table 7 Elements and Criteria for TPM Green Belt Certification

Graduation Elements	Sub Score	Passing Score
Class Attendance & Participation	20	10
Homework Assignments	20	10
Paper Test *(for some topics)*	10	5
Consultation Project	50	25
Total	**100**	**75**

6. Conclusion and Recommendations

In this article we show a development program for CI knowledge and ability for quality management engineer in a company in Thailand. As our company main CI program based on TPM approach, we looked first at what are readily available as suggestions from the TPM consultants we have been working with. Unfortunately, framework and suggestions from TPM consultants, concerning people development, focus mainly on production operators and maintenance staffs. Moreover, they outline education and training approach in detail only for frontline level staffs. This lefts us on our own, to find, by trial-and-error, the way to improve other employees (i.e. in other job functions, or hierarchical level) to support our CI initiative, especially the TPM. From more than 30 years of experience working with external consultants to implement continuous improvement initiatives, from ISO, TQM, till TPM, we have learnt and tried to synthesize our own way of people development. And it finally came out to be tested as a pilot program for engineers (who are responsible for promoting/ driving TPM program) – what we call *"TPM Green Belt"* for QM engineers.

Therefore, we have outlined all the elements of this program in order to show the readers how it helps shaping our engineers to be able to work with CI knowledge and abilities (i.e. mindsets and skills.) As of the time we finalized this paper, the development program was still on-progress, i.e. half way through the scheduled time-frame. Even though we might not be able to conclude that all the learners (this first batch has eight learners in total) have improved their knowledge and skills and behave in a new way that we planned for them, we could, in some extent, say that they have improved in the correct direction with a promising results that we aimed for. Thus we would like to share our process, design and preliminary result of this development program with the readers of this article to provide ideas to create their own program like ours.

To recap, this TPM Green Belt program aims to develop internal consultants for TPM implementation, as it is the main responsibility for QM engineers in the studied company. The program has six main components that work together accordingly. First, the program follows '*blended learning approach* – 70:20:10.' This design aspect ensures that the learning approach, delivering knowledge, skills, and experiences gained in this program, is highly effective. Second, the contents of this program contain not only technical knowledge and skills (i.e. TPM knowledge and principles, CI approaches – problem solving and task achieving approaches, and CI tools and techniques) but also soft skills (i.e. change management and people management knowledge and skills.) These two groups of knowledge are a complete set of knowledge and skills that, from experience of our SMEs, are needed for effective consultation for CI.

Third component is the individual consulting project assignment. We asked the learners to prepare a real CI case as a practice consultation case for this program (more than one, if possible.) Throughout

the learning program, parallel with classroom and workshop trainings, we used this real CI case as a platform for learning-by-doing on the real life situation – problems, people issues, and unforeseen changes and turbulences. This enhances our learners to be able to practice the *'20'* and *'70'* parts in the blended learning design. Moreover, the success of this CI case will be accumulated into the work portfolio of the learners, thus building credit and self-confident of the learners as well. Fourth, we also assign individual coach (i.e. one-on-one) to each learner. The coach acts as a personal tutor, advisor, mentor, and evaluator (for graduation) for each learner, improving learning experience of the learner in a much customized way.

Fifth, we also design two instruments to support both learning experiences as well as future works of our learners. First instrument is a learner's passport for reflective dialogue. This booklet is used to record learning and reflections of both a learner and his/her coach. It is also used as a material for pivoting point in individual reflective dialogue (i.e. every time after a practice consulting session) and group reflective dialogues (i.e. organized regularly much like a CoP, or SMEs experience sharing session.) The second instrument is the consultation manual, with checklists of minimum requirement. The learners use this manual and checklists as a guideline when they practice their consultation. More importantly, this manual will later become handy for the learners once they graduate to be internal consultants for their organization. Finally, the last component is the evaluation and conditions for certification as a *'TPM Green Belt'* engineer. This last component is designed so that we can ensure the quality of our learners when they pass and complete all the classes, assignments and practices.

Some learning points and precautions have been recorded along the way, and we would like to share with readers some of the most valuable for us, as following:

(1) Contribution from all stakeholders, for our case including the learners' managers, the practiced groups that do CI (i.e. customers), QM SMEs (i.e. as coaches), is very important since the development process involves using a real life work as practice platform and it is quite demanding. Thus the consensus and clear understanding of objectives, expectations, and resources demanded of all people involved are keys to the success and practicality of this new way of development.

(2) How to deliver training and development according to the 70:20:10 approach is key to maximize learning experiences of learners. Traditionally training and development courses are heavily based on classroom approach (i.e. the *'10.'*) Designing a proper and effective learning approach, especially integration of 70:20 approaches, one has to carefully craft learning instruments, activities, and methodologies. This is quite difficult and time (and resources) consuming, much more than the traditional lecture-type class. So be prepared!

(3) Soft-side (i.e. mind-set and behaviors) issues are also important for both process (i.e. developing this TPM Green Belt development program, and sell it to all stakeholders involved) and result (i.e. TPM Green Belt engineer with required knowledge and skills, who is going to work in the real company setting after certified) of this development program.

   a. First, to sell this new certification program to learners' managers is somewhat a hard job because this new way requires the learners to dedicate their time and resources working with coaches and instructors throughout the program. Moreover, to gain support and welcoming arms from the QCC improvement teams the learners are going practice consultation with is also very important, since they are the one who work on the CI case and the one who are going to be a crucial part of learners' practicing experience.

   b. Second, to be a good SME or specialist that performs tasks that help other to change (i.e. change for better or improvement), one needs to possess, at least, change

management and consultation skills. Thus inputs from soft-side experts are truly appreciated to guarantee both successful processes and results.

(4) Most of the time, many organizations do not often start from scratch, they usually have some development program available in their organization, or even those that are available publicly by external institutions (i.e. a famous '*build-borrow-buy'* strategy). As a result when we compiled the learning and development solutions, it was very useful to look at those readily available and pick-up some to use. So we do not need to re-invent the wheel.

(5) It is important to think in terms of what we want 'to-be' not what we are currently at. Therefore we design our future and how we prepare our capabilities and competencies for the upcoming tasks. Sometime we found that we easily slipped into discuss very much on how we do things now differently from each other, not how we want to do things differently (i.e. better) in the future.

(6) Lastly, as many persons in our working team voiced their concerns, this capabilities and competencies development project will go completely wasted if there is no other complementary elements developed together to support each other. These elements or systems might be, for example, employee's career path and career development, and linkages to company direction in medium-to-long term span. These will together enhance learning motivation of the learners as they can see their future clearer.

Though our approach has not yet been tested, as mentioned earlier, our initial reflections and evaluations ensure that it should somehow deliver satisfactory outcomes. Especially since this area (i.e. specifically to QM and CI people development) we hardly find somewhere else both in academic and practitioners' publications, we hope that this article will, at least, shed some light into how we could develop and enhance capabilities and competencies of employees who work in the areas of quality management and continuous improvement.

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