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Integrating ISO 10006/PMBOK into PDCA in a project-driven organization

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Abstract

This paper develops a Plan-Do-Check-Act (PDCA) management-oriented project management system to improve the quality system processes of a project-driven organization based on ISO 10006 and Project Management Body of Knowledge (PMBOK) function-oriented quality systems. The organization's functional processes are transformed into 10 management-oriented PDCA quality system, linked with ISO 10006 function-oriented quality system, and implemented as follows. Three management-oriented processes belong to "Plan" process, two processes belong to "Do" process, three belong to "Check" and "Act" processes and, finally, two processes run based on "PDCA" cycle. Recently, this organization has received ISO 9001: 2001 certificate by which significant external and internal benefits are achieved. In conclusion, integrating ISO 10006/PMBOK function-oriented quality system into a PDCA management-oriented one provides an effective quality system that guarantees a unified effort toward customer satisfaction and continual improvements.

Key words**:** Project-driven organization; ISO 10006; PDCA; PMBOK

目 錄

圖表目錄

1. Introduction

A project can be defined as a unique process, consisting of a set of coordinated and controlled activities with start and finish dates, undertaken to achieve an objective conforming to specific requirements, including the constraints of time, cost and resources.

Harold [1] defines "project management" as the planning, organizing, directing, and controlling of company resources for a relatively short-term objective that has been established to complete specific goals and objectives. Furthermore, project management utilizes the systems approach to management by having functional personnel assigned to specific project.

The principles of project management can be applied to any type of project and to any industry. Among the researches that contribute to project management development are as follows. Hameri [2] discusses the project management issues in global one-of-a-kind projects with several years of duration along with considerable design and engineering work. Williams [3] suggests developing project risk management framework that inform teams about likely cross-impacts, limiting team empowerment, and allowing team to influence decisions. Reichelt and Lyneis [4] argue that the failure to improve project performance results, in large part, from models that do not treat projects as the complex dynamic systems which they are. Steyn [5] extends the application of theory of constraints (TOC) beyond critical chain scheduling to manage resources shared by a number of concurrent projects. Jaafari [6] proposes a strategy-based project management philosophy and methodology which integrates planning, decision making and risk management, and enables real time optimization of the project's strategic goals versus its variables. Baccarini and Archer [7] focus on risk rating process at three major phases of the contracting process; procurement planning, contract development, and contract management. Raz and Michael [8] present the results of a study which is designed to investigate the tools that can provide the greatest benefits during the adoption or improvement of a project risk management process. Wei *et al.* [9] compare and contrast the advantages and disadvantages of traditional project management and TOC project management. An enhanced TOC method for scheduling the project under resource constraint is also proposed. Swink [10] addresses how accelerated time goals affect the execution and completion of new product development projects relative to project content, project leadership and aspects of design integration. Hartman and Ashrafi [11] develop a planning approach to project planning, integrating both hard and soft aspects, enhancing current tools and techniques, and improving the project planning process by providing internal validation. Soderlund [12] introduces a discussion and debates about some fundamental theoretical issues related to project management research.

1.1 PMBOK and ISO 10006

The quality of project and project product (s) plays a critical role in customer satisfaction. There are two aspects to the application of quality in project management: the quality of the project processes and the quality of the project product. PMBOK refers to quality control as the technical aspect of quality management, where the members of project team play an active role in quality control. Project team members usually set up the technical processes and procedures in order to ensure that each process of the project provides a quality output from design and development through implementation and maintenance. The output of each process should conform to the overall quality standards and quality plans, thus assuring that quality is achieved. PMBOK [13] outlines project management processes as shown in Table 1 into nine function-oriented processes.

The ISO 10006 standard [14] emphasizes the process approach of quality system, which means that all processes, their management, and their mutual interactions are interrelated. The guidelines to quality system in project management are provided in ISO 10006, in which implied that project management includes the planning, organizing, monitoring and controlling of all aspects of the project in a continuous process to achieve its objectives. ISO 10006 categorizes project processes into ten function-oriented processes. The relevant ISO 10006 clauses with their corresponding sub-clauses integrated with PMBOK are displayed in Table 1.

Table 1: Integration of ISO 10006 guidelines with PMBOK.

ISO 10006	Description	Corresponding PMBOK process	Description
Clause 5.2 Strategic process	5.2.1 Satisfaction of the customer's and other stockholder's stated and implied needs is paramount. 5.2.2 A project is carried out as a set of planned and interdependent processes. 5.2.3 A focus on the quality of both processes and products is necessary to meet the project objectives. 5.2.4 Management is responsible for creating an environment for quality. 5.2.5 Management is responsible for continual improvement.	8. Project Quality Management	8.1 Quality planning 8.2 Quality assurance 8.3 Quality control
Clause 5.3 Interdependency Management process	5.3.1 Project initiation and project plan development 5.3.2 Interaction management 5.3.3 Change management 5.3.4 Closure	4. Project Integration Management	4.1 Project plan development 4.2 Project plan execution 4.3 Overall change control
Clause 5.4 Scope-relate processes	5.4.1 Concept development 5.4.2 Scope development and control 5.4.3 Activity definition 5.4.4 Activity control	5. Project Scope Management	5.1 Initiation 5.2 Scope planning 5.3 Scope definition 5.4 Scope verification 5.5 Scope change control
Clause 5.5 Time-related processes	5.5.1 Activity dependency planning 5.5.2 Estimation of duration 5.5.3 Schedule development 5.5.4 Schedule control	6. Project Time Management	6.1 Activity definition 6.2 Activity sequencing 6.3 Activity duration estimation 6.4 Schedule development 6.5 Schedule control

Clause 5.6 Cost-related processes	5.6.1 Cost estimation 5.6.2 Budgeting 5.6.3 Cost control	7. Project Cost Management	7.1 Resource planning 7.2 Cost estimating 7.3 Cost budgeting 7.4 Cost control
Clause 5.7 Resource-related processes	5.7.1 Resource planning 5.7.2 Resource control		
Clause 5.8 Personnel-related processes	5.8.1 Definition of project organizational structure 5.8.2 Staff allocation 5.8.3 Team development	9. Project Human Resources Management	9.1 Organizational planning 9.2 Staff acquisition 9.3 Team development
Clause 5.9 Communication-related processes	5.9.1 Communication planning 5.9.2 Information management 5.9.3 Communication control	10. Project Communications Management	10.1 Communications planning 10.2 Information distribution 10.3 Performance reporting 10.4 Administrative closure
Clause 5.10 Risk-related processes	5.10.1 Risk identification 5.10.2 Risk estimation 5.10.3 Risk response development 5.10.4 Risk control	11. Project Risk Management	11.1 Risk identification 11.2 Risk quantification 11.3 Risk response development 11.4 Risk response control
Clause 5.11 Purchasing-related processes	5.11.1 Purchasing planning and control 5.11.2 Documentation of requirements 5.11.3 Evaluation of subcontractors 5.11.4 Subcontracting 5.11.5 Contract control	12. Project Procurement Management	12.1 Procurement planning 12.2 Solicitation planning 12.3 Solicitation 12.4 Source selection 12.5 Contract administration 12.6 Contract close-out

In Table 1, each of ISO 10006 clauses has an equivalent process in PMBOK processes. Thus, PMBOK and ISO 10006 agree on the required processes to achieve a quality system in any type of project.

Many researchers integrate quality system requirements with project management processes. For example, Auer *et al.* [15] discuss the development and use of ISO 9001-based quality management system for embedded systems research and development (R&D) projects. Walker [16] reviews a national project to develop a checklist to probe ISO 9001 requirements for software field and offer guidance for examining the effectiveness of implementing process clauses in software domain. Serpell [17] investigates the problems, limitations and benefits expected from the integration of quality systems based on ISO 9000 in Chilean construction projects. Special focus is given to the impact that quality systems have on the owner-contractors relationship. Pheng and Abeyegoonasekera [18] analyze a condominium project to examine the extent to which the quality elements of ISO 9000 are applied to the project to enhance its buildability and to determine the effectiveness of integrating buildability in ISO 9000 quality management systems. Ojanen *et al.* [19] promote effective R&D management by utilizing a systematic analysis approach based on Malcolm Baldrige Quality Award Criteria framework in order to propose new measurement subjects and evaluation methods or concrete measures for R&D projects. Chin *et al.* [20] present a function-oriented quality management information framework to improve the productivity of the quality system process based on ISO 9001:2000. Labodova [21] implements an integrated management system that includes quality management system, environment management system, and occupational health and safety management system based on an established risk assessment methodology.

1.2 PDCA and ISO 10006

The ISO 10006 process approach emphasizes the role of top management in establishing an effective quality system that enables interlinks of function-oriented processes within this system. In these regards, the purpose of this paper is to establish and implement an effective PDCA quality management system which complies with ISO 10006/PMBK in a project-driven organization. That is, the function-oriented quality system provided by ISO 10006/PMBK will be linked with PDCA management-oriented quality system. Doing this enables the organization, under study, receiving ISO 9001: 2001 certificate and provides a project environment in which the managerial and functional efforts are combined toward achieving customer satisfaction and continual improvement.

This paper is organized as follows including introduction. Section two presents the project-driven organization under study. Sections three to six discuss PDCA management processes. Conclusions are presented in section seven.

2. Project-driven Organization

The project-driven organization, under study, performs several project function-oriented processes within each project. This organization aims at transforming and combining these processes into management-oriented processes to improve project performance, project/product quality, and project control. Therefore, the project processes in this project organization are transformed into ten main management-oriented processes. The flow chart that routes these processes with the corresponding functional departments of interest is depicted in Fig. 1.

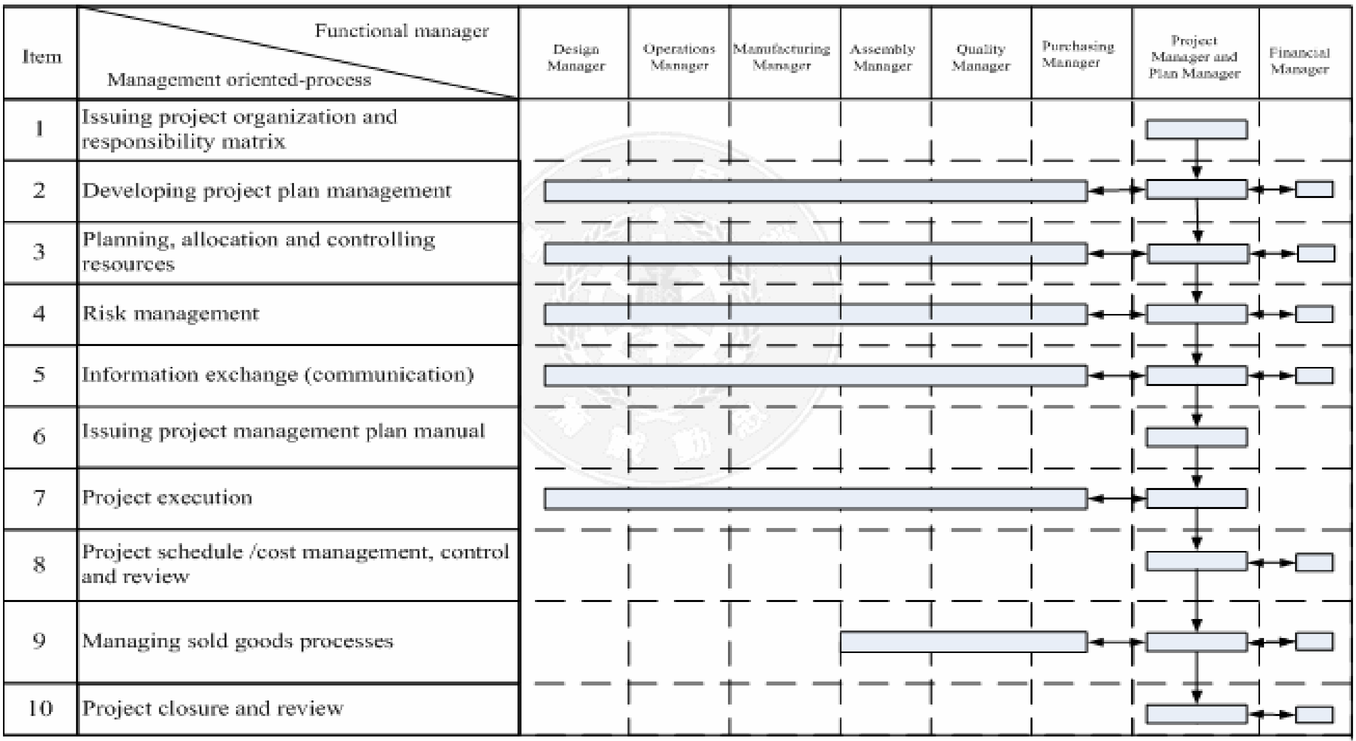

Figure 1: Flow chart of project management-oriented processes

The organization under study aims to receive ISO 9001 certification by following ISO 10006, which also implies that the project organization fulfills PMBOK processes. Consequently, the project organization processes; shown in Fig. 1, are linked with ISO 10006 function-oriented processes. Moreover, the project

Integrating ISO 10006/PMBOK into PDCA in a project-driven organization

processes are integrated with PDCA managerial-processes as given in Table 2.

Table 2: Integration project processes with ISO 10006 and PDCA

Project Process	PDCA	ISO 10006
Issuing project organization and responsibility matrix	Plan	Clauses 5.2, 5.4, 5.8
Development of project plan management	Plan	Clauses 5.3, 5.5-5.7, 5.11
Planning, allocation and controlling resources	Plan	Clauses 5.7, 5.11
Issuing project plan manual	Do	Clauses 5.2, 5.4
Project execution	Do	Clauses 5.2, 5.3, 5.5, 5.7, 5.9
Project schedule /cost management, control and review	Check-Act	Clauses 5.2, 5.3, 5.5, 5.7-5.9
Managing sold goods processes	Check-Act	Clauses 5.2, 5.9
Project closure and review	Check-Act	Clauses 5.2, 5.3
Risk management	Plan-Do-Check-Act	Clause 5.10
Information exchange	Plan-Do-Check-Act	Clauses 5.3, 5.9

The “Plan”, “Do”, “Check”, “Act” and PDCA processes which are listed in Table 2 will be discussed in the following sections.

3. Plan process

The ISO 10006 clauses that are covered in “Plan” process are shown in Table 2. In this section, the three function-oriented processes belong to this process will be discussed as follows.

3.1 Issuing project organization and responsibility matrix

Strategic process (clause 5.2) is a direction-setting process that organizes and manages the realization of the other project processes. In this context, the project organization under study which is a matrix type organization carries out many concurrent projects where each project represents a potential profit center. Typically, the project manager has total responsibility and accountability for project success, while the functional departments have functional responsibility to maintain technical excellence on the project. Each functional unit is headed by a functional manager whose prime responsibility is to ensure that a unified technical base is maintained and that all available information can be exchanged for each project.

In scope related processes (clause 5.4), the project manager coordinates and integrates activities across multiple functional units in order to develop, execute, and make changes to the project plan. Thus, the project manager usually develops work breakdown structure (WBS), which structures the work into small manageable independent, integratable, and measurable elements

Further, the interface and integration between project office and the functional units composes the project organization or project team. The project office is an organization developed to support the project manager in carrying out his duties. The major responsibility of the project manager and the project office personnel is the integration of work across the functional units of the organization. The project organization structure is shown in Fig. 2.

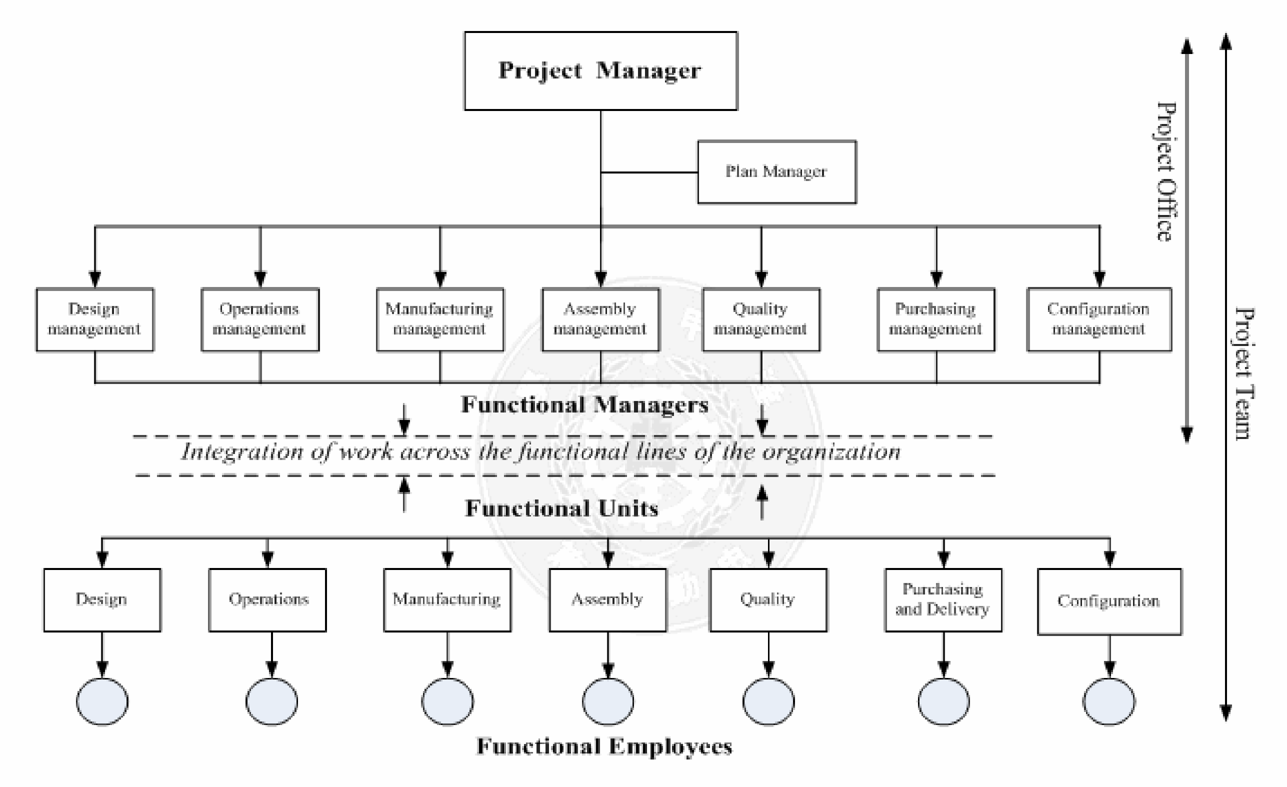

Figure 2: .Project organization structure.

The personnel-related processes aim to create an environment in which people can contribute effectively and efficiently to the project (clause 5.8). In these regards, the project team develops a responsibility assignment matrix (RAM) that contains the functional and project office members. The RAM shown in Fig. 3 attempts to clarify the authority relationships that can exist when functional units share common work.

Item	Functional Unit / Responsibility	Project Office	Design Unit	Operations Unit	Manufacturing Unit	Assembly Unit	Quality Unit	Purchasing and Delivery Unit	Configuration Unit
1	Plan management and resource allocation	□							
2	Issuing quality plan						□		
3	Blueprint and product design		□	□			□	□	□
4	Material requirement planning		□	□					□
5	Purchasing management							□	
6	Product components manufacturing and assembly			□	□	□	□		
7	Taxes, customs and transportation management							□	
8	Project configuration management								□
9	Sales and administration	□							

Figure 3: Project responsibility assignment matrix (RAM).

The responsibilities of each unit shown in this figure can be described as follows:

1. Project office is responsible for planning, coordinating, and integrating activities among all project processes in order to achieve project goals and objectives. In most cases, the project manager provides overall or summary definitions of the work to be accomplished, while the functional managers do the detailed planning. On the other hand, plan manager is responsible for assisting the project manager in planning and controlling of the project processes from the project initiation till closure.

2. Design unit is responsible for preparing project blueprints and design verification, handling design change and conflicts, and coordinating with project manager and

functional units regarding project design.

3. Operations unit is responsible for providing and coordinating material requirement planning for manufacturing/assembly of parts, preparing tools design and assignments, and coordinating with manufacturing/assembly units regarding the progress of manufacturing/assembly processes.

4. Manufacturing unit is responsible for scheduling and performing project manufacturing-related processes and labor distribution in such a way that the planned time, cost, quality, and performance criteria are met. Moreover, this unit reports, updates, and evaluates the progress of manufacturing schedules.

5. Assembly unit is responsible for scheduling and carrying out project assembly-related activities within time, cost, quality, and performance constraints. Assembly unit also handles labor assignment, coordinates and evaluates project assembly progress, and reports and updates assembly schedules.

6. Quality unit is responsible for establishing and issuing the quality-related documents, quality plan manual, and controlling projects documents and records. In addition, this unit performs quality control activities, conducts measurement and improvement activities, and coordinates with project management regarding any quality-related issues.

7. Purchasing and delivery unit is responsible for handling materials purchasing

activities, selecting and evaluating suppliers, and coordinating with project manager and functional managers regarding delivery dates. Further, this unit coordinates with accounting unit regarding purchased materials prices, updates purchasing, and delivery schedules, and completes purchasing and delivery related-documents and forms.

8. Configuration unit is responsible for systematically recording and archiving all the changes in order to provide the necessary information for the later steps of the project. Configuration unit is also concerned with the control of specification changes and the work/information/data flow during design and manufacturing/assembly/delivery processes.

3.2 Development of project plan management

Projects consist of processes and an action in one of these usually affects others (clause 5.3). Consequently, the project manager and project office members are responsible for project plan management. Initially, each project is assigned a unique code for ease of traceability and evaluation. Each project has its own profit-and-loss statement. Thus, all project-related processes that consume time, cost, and resources are charged accordingly to their corresponding project through the use of project code. Project time and cost will be discussed in the following subsections.

3.2.1 Project time

The project office assigns a time estimate for the duration of the project based on the times consumed for the overall WBS of the project (related to clause 5.5). Gantt chart and critical path method are adopted for project scheduling, while the progress evaluation is computed based on the nature of each activity. Several methods are adopted to evaluate project progress including:

1. 50/50 method; which implies that as soon as project is started, project progress is 50%. However, when work is completed, progress is considered 100%.
2. 0/100 (20/80) method; which indicates that when work is not yet completed, project progress is evaluated as 0 % (20%), whereas, when work is completed, progress becomes 100%.
3. Efficiency method; which uses the percentage of the realized output relative to the planned output to calculate project progress.

Then, each work in WBS is assigned a weight or factor based on:

1. the ratio of work hours needed to all project hours;
2. the ratio of work budget to the overall project budget;
3. work importance, where high weights are given to critical path processes;
4. the above three techniques, a hybrid technique that considers a trade-off

strategy between time and cost that can provide a more reasonable and realistic weight.

Finally, the entire work progress is computed by multiplying the work weight by its corresponding progress.

3.2.2 Project cost

Project costs are broken down into operation (variable costs) and implementation (fixed costs) categories (related to clause 5.6). For project cost planning, the project office utilizes the WBS in order to assign the corresponding cost for each work. Project costs can be related directly or indirectly to the project product. The project cost breakdown structure is shown in Fig 4.

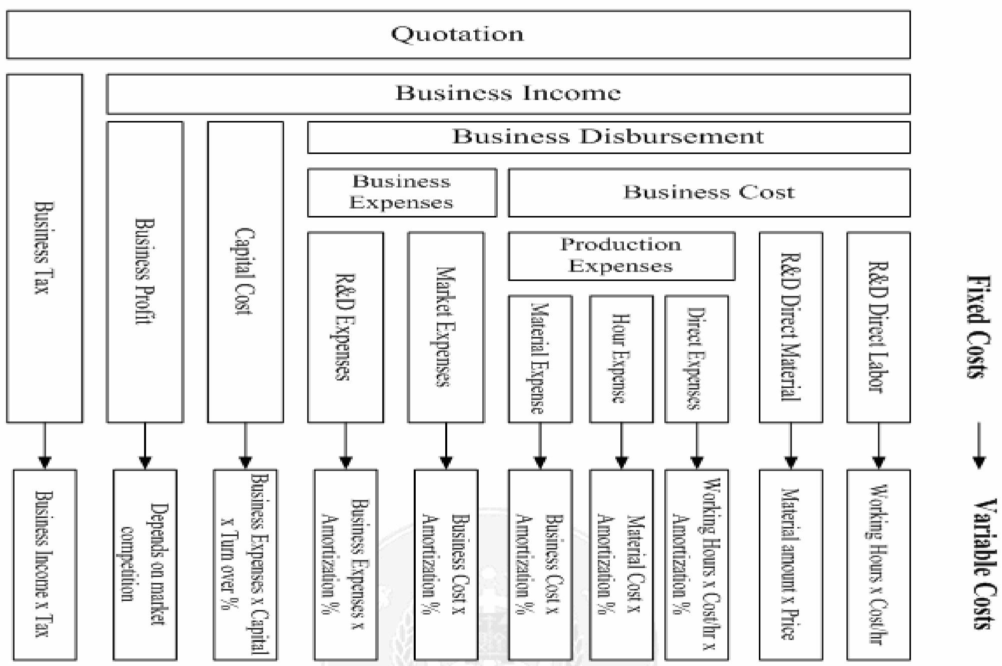

Figure 4: Cost breakdown structure.

From Fig. 4, direct working-hours refers to directly personnel engaged in project products R&D and manufacturing, while the cost of personnel who are not directly engaged are considered indirect workings-hours. Similarly, direct material is the material which is directly contributed in production, assembling of a product. However, indirect material is not directly contributing to the product itself; for example product packaging material. Direct expenses include general expenses which are directly applied to products; such as documents, packaging, and transportation expenses. Usually, direct costs are accompanied by indirect costs or expenses. This is referred to as "amortization %" in the project cost breakdown structure. Further, quotation is the sum of business income and business tax. Business income includes business disbursement, capital cost, and business profit. Business disbursement is the sum of business expenses and business cost. Business expenses include marketing expenses and R&D expenses. While, business cost is the sum of production expenses, R&D direct material, and R&D direct labor.

3.3 Planning, allocation and controlling resources

The project office allocates the necessary resources to accomplish the work and decides if part of the work has to be outsourced (related to clause 5.7). The resources include the required man-power hours, material, and other resources that enable the functional unit to carry out the intended work (related to clause 5.11). Resources are allocated based on technical criteria agreed on by the project office. Functional managers are responsible of allocating the needed resources for all WBS processes. Resource buffers are usually added to the processes on the critical path. Finally, the overall resources plan is approved by top management including the project manager.

4. Do process

The ISO 10006 clauses that are covered in “Do” process are shown in Table 2. In this section, the management-oriented processes which belong to “Do” process will be discussed.

4.1 Issuing project plan manual

The project plan manual is the guidelines for the executive project management (related to clause 5.2). This manual is the core of the quality management system and describes different phases and tasks of projects, management of the tasks, and procedures for internal auditing and improvement according to ISO 10006 principles. The project plan manual includes (related to clause 5.4):

1. project policy and objectives, which imply that the project processes are

effectively managing project execution, guarantying that project elements provide products and services that conform to the customers requirements, and producing high quality products with minimum cost by efficiently labor-division and management.

2. project scope and procedures, which ensure that the stated customer requirements mentioned in the contract are fulfilled and describe the product characteristic; such as quantity, important milestone, conditions of delivery goods, and payment conditions.
3. project organization and responsibility, which explicitly define authorities and responsibilities of each participant in the project organization.
4. project human resources and training, which describe the staffing, human resources training, and administrative procedures.
5. project documents, which contain all necessary documents and records that will be used throughout the project life cycle; such as project quality plan manual, project technology documents, project product standards documents, project cost accounting, and weekly reports.

Further, if any changes take place during the project life cycle, this manual is revised and configuration management has the responsibility to ensure that latest version of this manual is maintained at each functional or nonfunctional unit.

4.2 Project execution

This stage initiates the implementation of the project where all efforts are collaborated and unified to achieve the project goals and objectives based on customer requirements and expectations (related clauses 5.2 and 5.3). Effective communication, leadership and conflict management play a key role at project execution stage (related to clause 5.9). In addition, effective adoption of suitable measures is maintained to ensure each project activity progressing within time, cost, and resource constraints (related to clauses 5.5-5.7).

During project execution, each functional unit is responsible for carrying out the intended work and resolving any problem that could obstacle project progress. If further clarifications are needed from customers or other functional units, this functional unit submits a report to its functional manager which includes information; such as project code, contract number, and information required. Then, functional manager communicates and coordinates with other functional managers or project manager (in case customer involvement is required) regarding the required information (related to clause 5.3). Further, effective procedures of identification and traceability for each activity are set in order to simplify activity monitoring and controlling.

5. Check and Act processes

The ISO 10006 clauses that are covered in “Check” and “Act” processes are shown in Table 2. In this section, the management-oriented processes belong to “Check” and “Act” processes will be discussed.

5.1 Project schedule/cost management, control and review

The project execution may encounter that (1) some functional units are overloaded and thus cannot send enough and suitable man-power (team) to execute the project, (2) the project expenditure is exceeded due to improper project cost control, (3) the talented persons are insufficient due to that some of the projects staff left or the accident injury, (4) delivery of purchased materials is delayed, and (5) the project cannot progress smoothly due to unexpected problem(s) that cannot be solved by technology. In these regards, project control plays a key role in project management that aims to reduce the obstructive event.

Project control is a three step process of measuring progress toward the desired project objectives, evaluating the remaining work that have to be done, and implementing the necessary corrective action to achieve and/or exceed the objectives. Project control includes measuring process (related to clauses 5.5-5.8); evaluating process (related to clause 5.2); and correcting process (related to clauses 5.3 and 5.9). Measuring process determines through formal and informal reports the degree to which progress toward objectives is being made; for example weekly progress report. Evaluating process identifies causes of significant deviations from planned performance. Finally, correcting process takes control action to correct an unfavorable trend or to take advantage of a favorable trend; such as planning for contingencies, responding to critical problems, conducting effective meetings, and closing projects effectively and efficiently.

5.2 Managing sold goods processes

These processes are directly related to the finished products, in particular, where shipping, packaging, and transportation take place. Assembly and delivery unit has the responsibility for fulfilling customer's requirements in the assembled products (related to clause 5.2). Besides, effective communication between this unit and accounting is maintained for better handling customers-related issues with regard to delivered products (related to clause 5.9); such as issuing invoices and financial statement. Customer comments and complaints are usually received by project manager and handled by functional unit(s) with related scope and responsibilities. That is, if the customer complains about product quality, quality unit is incharge of resolving this complaint with the coordination of the related functional unit.

5.3 Project closure and review

The project closure and review process evaluates efforts of the total system and serves as input to the conceptual phases for new projects (related to clause 5.3). In addition, this process has an impact on other on going projects with regard to identifying priorities and providing learned lessons during problem solving efforts (related to clause 5.2). Usually, two steps are carried out during this process. First, plan manager updates the status of the current project code as “closed” instead of “in progress”. Second, project manager prepares a project summary report which (1) provides the top management project information about project accomplishments, (2) includes evaluation of the key project performance factors (project time, cost, and quality), and (3) sets performance standards and includes learned lessons that could be considered as a planning and problem-solving reference for future similar project.

6. PDCA cycle

The ISO 10006 clauses that are covered in PDCA cycle are shown in Table 2. Two management-oriented processes run based on PDCA cycle. These processes will be discussed as follows.

6.1 Risk management

Risk management is not a separate project office activity assigned to a risk management department, but rather is one aspect of project office responsibilities. Project office is responsible for risk management in this project (related to clause 5.10). In this organization, project office manages project risk by:

1. Proposing the important risk identification utilizing the WBS based on cost, time, and technical evaluations. Cost evaluation builds on technical and schedule evaluation results. Time evaluation evaluates baseline schedule inputs and reflects inputs from technical and cost areas. Technical evaluation evaluates technical foundation and identifies project risks, analyzes risks and relates them to other internal and external risks, prioritizes risks for project impact, analyzes associated project activities with both time duration and resources, analyzes inputs for cost evaluation and schedule evaluation and, finally, documents technical basis and risk issues for the risk evaluation.
2. Converting the results of risk identification into risk ratings and risk probability. Risk ratings indicate the potential impact of risks on a project. They are typically a measure of the likelihood of an issue occurring and the consequences of the issue, and often expressed as low, medium, and high. High risk has a substantial impact

on cost, schedule, or technical. Substantial action is required to alleviate issue with high priority management attention. Moderate risk has reasonable impact on cost, schedule, or technical, where special action may be required to alleviate issue, while additional management attention may be needed. Low risk has minimal impact on cost, schedule, or technical. Meanwhile, normal management oversight is sufficient. Risk evaluation is summarized in Table 3**.**

Table 3: Risk evaluation.

Risk Probability	**Risk Rating**	**Risk Impact**		
		Time interval (weight 34%)	Cost (weight 33%)	Performance (weight 33%)
0.9	0.8 ≤ Risk ≥ 1.0 High probability of occurrence	Risk severely delays the project duration more than 3 months and affects milestones and scheduling.	More than 50% additional budget is required.	The objective performance is impossible to be achieved when the risk occurs.
0.7	0.6 ≤ Risk <0.8 High probability of occurrence	Risk occurrence delays the project time 2 to 3 months.	20% to 50% additional budget is required.	The objective performance is hardly achieved when the risk occurs.
0.5	0.4 ≤ Risk <0.6 Middle probability of occurrence	Risk occurrence will delay the project 1 to 2 months.	5% to 20% additional budget is required.	The objective performance can be possibly achieved with additional technology and capacity (resources).
0.3	0.2 ≤ Risk <0.4 Low probability of occurrence	Risk occurrence will delay the project between 1 week to 1 month.	2% to 5% additional budget is required.	The objective performance can be achieved by rescheduling and adding more capacity (resources).
0.1	0.0 ≤ Risk <0.2 Low probability of occurrence	Risk occurrence will delay the project up to 1 week.	Less than 1% additional budget is required.	The objective performance can be managed by a slight additional capacity or reallocating resources.

3. Defining degree of risk control and the corresponding impact on the project. The degree of risk control is divided into three grades: high, middle, and low. If the control degree is high, there is no influence on the final impact value. If the control degree is middle (low), there is 10% (20%) influence on the final impact value.
4. Conducting risk analysis. Risk analysis begins with a detailed study of the risk issues that have been identified and approved by project office for further evaluation. The objective is to gather enough information about the risk issues to judge the likelihood of occurrence and cost, schedule, and technical (performance) consequences if the risk occurs. As shown in Table 3, cost, time, and technical evaluations are given equal weights of importance; 34%, 33% and 33%, respectively. Then, the impact of cost is obtained from multiplying cost weight of importance by probability of occurrence. Similar computations are done for both time and performance factors. The impact value is the sum of factors impacts.
5. Preparing risk summary report which contains risk identification, ratings and impact value analysis, handling procedure and incharge functional unit, and suggested tools for monitoring.
6. Tracking and monitoring risk handling actions and continuously developing effective risk prevention plans and handling actions.

6.2 Information exchange

Effective information exchange or communication is critical to the success of a project that ensures the right information is delivered to the right person at the right time and in a cost-effective manner (related to clause 5.9). There are two types of information exchange which take place in the project life cycle (related to clause 5.3); internal and external information exchange. Internally, projects are run by communication where the work is usually defined by the communication tool according to WBS. The project office may spend 90% or more of their time communicating. Externally, effective external communication media and tools are established; including coordinating with customers, suppliers, subcontractors, and other parties.

Recently, the PDCA management-oriented quality system has enabled the project-driven organization under study receiving ISO 9001: 2001 certificate. This brings good opportunities to this organization for having more future projects, increases its competitiveness abilities, and enhances customer satisfaction. Internally, this organization enjoys significant improvements in its quality system; including effective team work among managerial and functional levels to produce high quality project products, deliver projects on-time, and increase profits.

7. Conclusions

The quality of project and project product (s) plays a critical role in customer satisfaction. Customer satisfaction requires integrated efforts among managerial and functional levels. ISO 10006 and PMBOK have equivalent function-oriented processes for project quality system and emphasize on responsibility of top management for implementing effective quality system. PDCA cycle provides a management-oriented approach for effective quality system. Consequently, this paper establishes and implements a combined quality system approach by integrating PDCA management-oriented processes with ISO 10006/PMBOK function-oriented processes. In conclusions, the standards provided by ISO 10006/PMBOK can serve as an important platform for establishing PDCA processes by which management and functional processes are combined toward enhancing customer satisfaction, improving projects/products quality and continual improvements. The combined quality system promotes the organization under study to enjoy significant internal and external benefits.

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