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# Target Entities of Total Quality Management Based on the New TQM and Three-Dimensional Unification Value Models

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## Abstract

In recent years, the method of TQM (Total Quality Management) is widely recognized. However, contents of target entities for assessment are various, and it is very difficult to define the whole scope of TQM. On the other hand, it is very important to define the whole target entities of quality management about the TQM because lack of important target entities may cause significant risk of loss in future. Furthermore, target entities of TQM should correspond to needs and priority of an objective requirement and that should be based on the consideration of basic principle of quality management. In the previous study, we have proposed the "framework of new TQM" of assessment for a total quality management of organizations based on the original concept of "TQM matrix". On the other hand, we have proposed the view point of "Three-Dimensional Unification Value Models" for an evaluation of system product. Therefore, in this paper, we propose the target entities of whole assessment of quality management of organization totally based on the consideration of "New TQM framework" and the view point of "Three-Dimensional Unification Value Models". Also, this paper proposes the result of verification based on the result of comparison between proposed target entities of assessment and American Malcolm Baldrige Prize for Performance Excellence.

## 1. Introduction

Generally, for quality assessment of an organization management, TQM (Total Quality Management) is used

worldwide and recognized. The TQM has spread in USA in the 1990s, and to provide a high quality and suitable price of product and service at appropriate good timing for a customer satisfaction. In order to provide the best practice, TQM is the strategic system-like methodology for organization-wide quality control activities.

The TQM clarifies requirements for management quality of the organization by the examination standard for ex, American Malcolm Baldrige Prize [1]. In addition, the precedent study [2] tries the clarification of the important success factor of TQM that it is the basis of the examination standard from the findings of many example studies.

However, contents of target entities of assessment are various, and it is very difficult to define the whole scope of TQM. On the other hand, it is very important to define the whole target entities of Total Quality Management. Furthermore, target entities of TQM should correspond to needs and priority of an objective requirement and that should be based on the consideration of basic principle of quality control as shown in **Figure 1**.

If we select the wrong target entities of management or miss understanding about importance and priority of target entities. As a result, it may cause a significant risk of loss in the management quality of organization in future.

On the other hand, we have been working on the development of ISO/IEC25000 (SQuaRE) series of standards for quality requirements and evaluation of a system and software product [3]-[10] for a long time in ISO/ IEC JTC1 (Joint Technical Committee 1 of the International Organization for Standardization and the International Electro technical Commission) SC7WG 6 (software and systems engineering). As part of this project, we have worked on the developments of ISO/IEC25030 [7], 25040 [8], 25041 [9], which are the standards to provide supporting technique of method for quantitative quality requirement definitions and evaluation of system product. And, quantitative quality requirement and evaluation of system are executed from the view point of system and software product quality models defined in ISO/IEC9126-1 [10] (ISO/IEC9126-1 has revised by ISO/IEC25010 [6] at 2011). On the other hand, definition of system is "a combination of interacting elements organized to achieve one or more stated purposes" defined in ISO/IEC15288: 2008 Systems and software engineering-system life cycle processes [11]. However, organization having a specific purpose is a kind of system based on the definition of system. Therefore, it is thought that the evaluation technique of system product can be adaptive to the assessment of management quality of organization. Based on the above assumptions, previous study [12], we have proposed the "framework of new TQM". In the previous study, we have developed the "framework of new TQM" based on the concept of "system quality requirement and evaluation process defined" in ISO/IEC 25041 [9] and our original concept of "TQM matrix" [12]. Also, we have proposed the view point of evaluation for system product that is the "Three-Dimensional Unification Value Models" from the consideration of expanding the system product quality models defined in ISO/IEC9126-1 [10] in the previous study [13]. Therefore, in this paper, we propose the example of concrete target entities of TQM based on the consideration of "framework of new TQM" [12] and the view point of "Three-Dimensional Unification Value Models" [13] for product and process. Furthermore, this paper propose the result of comparison between proposed target entities and target entities for Performance Excellence of American Malcolm Baldrige Prize, and report the result of verification about the advantages of proposed target entities for TQM of organizations.
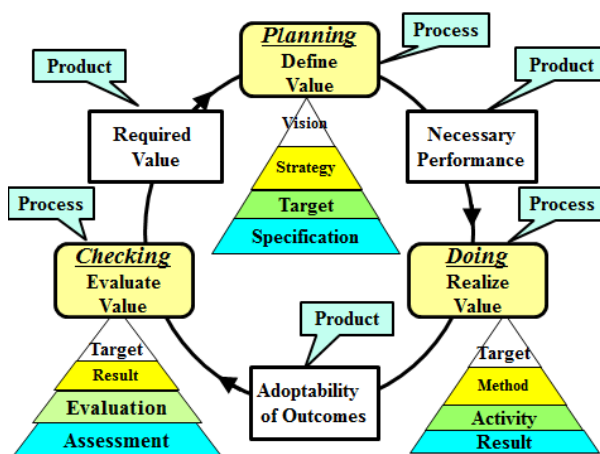


**Figure 1.** Basic concept of quality control.

## 2. Concept of New TQM

### 2.1. Basic Concept of Quality Control

**Figure 1** shows the basic concept of quality control that shows the relationships between process and product, and concept of the PDC cycle.

From **Figure 1**, every kind of activities includes a product and a process based on the consideration of basic concept of quality control. In addition, an input and outcomes of process are included in the activity of organizations. In order to improve a management quality of product and process, turning of cycle called PDC is necessary as shown in **Figure 1**. Also, the quality control activity is the repetition of product and process, which include a sequence of "product-process-product-process and product" during a PDC cycles. Outcomes product of a process before becomes an input product for the later process. All kind of management processes is affected by an input quality of own process, which is a result of previous management process. Therefore, the quality of process depends on a quality of previous process, and not to be able to exist alone each. For the purpose of improvement of quality of process, it is necessary to evaluate a quality of both input resources and outcomes essentially. In order to turn a PDC cycle, state of quality of target entities about product and process should be visualized. And it is necessary to measure target entities of product and process, and confirm the existence of problems.

- **PDC cycle**

  Generally, PDC is called PDCA as Plan-Do-Check.

  Action. An improvement activity should be performed immediately after checking and resolve the problems. But "Action" of improvement is same as "Do". Therefore some kind of plan should be studied in front of the improvement action because it is thought necessary. There is the risk that improvement activity leads to a change for the worse when we do not perform some kind of plan before improvement. Therefore, in this study, "PDCA" is called "PDC".

### 2.2. Concept of TQM Matrix

**Figure 2** shows the TQM (Total Quality Management) matrix, which has proposed by our previous study [12].

**Figure 2** shows the four target domains of new TQM, which has proposed by our previous study. It is recognized that the both conventional "Quality assurance" and "Quality improvement" is included in the management domains of new TQM. Also, it is recognized that the additional management domains such as the "Dynamic risk management (investment or project management) and Static risk management" is included in the TQM Matrix as shown in **Figure 2**. Static risk as shown in **Table 2** is defined as the scale of the damage and probability that a problem will produce in future when occurred. On the other hand, dynamic risk management as shown in **Table 2** should be performed based on the consideration of the view point of effectiveness, priority and limited input resources. And the "reception, imputation, reduction and evasion" process should be performed corresponding to the result of risk analysis of new TQM as shown in **Figure 2**.

### 2.3. Framework of New TQM

In the previous study [12], we have proposed the "framework of new TQM" that is necessary to lead an organization for success of improvement of management quality as shown in **Figure 3**.

The "framework of new TQM" has defined based on the consideration of quality requirement and evaluation process of system product quality defined in ISO/IEC25041 [9] and proposed our original concept of TQM matrix [12] as shown in **Figure 2**.

#### 2.3.1. Target Domains of Product

From **Figure 3**, four kind of target domains of the product such as "input, outcomes, constrain and resources" are defined in the "framework of new TQM".

And, target entities of product assessment of management quality should correspond to the each target domains of product.

- **Input:**

  Necessary resources should be taken from outside of organization in order to achieve purpose of activities.

  For example, human resources, facilities, materials, engineering, technique, etc.
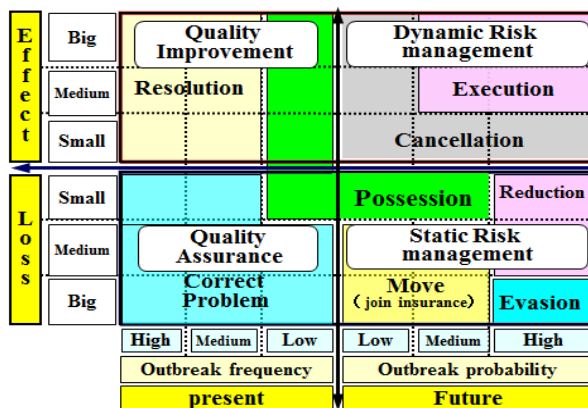
**Figure 2.** Concept of TQM matrix [12].
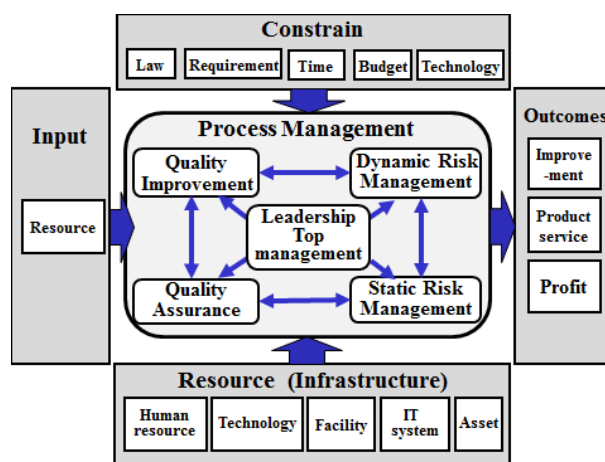


**Figure 3.** Framework of new TQM [12].

- **Outcomes:**

  Primary results of organization activities such as "products, service and improvement".

  Secondary result of organization activities such as "result of various improvements or negative effect such as environmental load".

- **Constrains:**

  It is the limitation of activities such as the purpose, requirement, budgets and time limit from agreement with outside or inside stakeholders. Also, include the limitation of activities such as the law, rule, standard, corporate strategy of the organization, financial resources, human resources, facilities environment and technologies, etc.

- **Resources:**

  It is the resources or infrastructures which is the organization helping practice of the organization activity holds. For example, infrastructure for supporting organization activities is categorized such as various management core technologies, human resources, information system, financial resources, facilities, materials, etc.

### 2.3.2. Target Domain of Process

From **Figure 3**, five target domains such as the "Quality assurance", "Quality improvement", "Static risk management", "Dynamic risk management (For ex, investment management or project management)" and "Leadership of top management" of process assessment are defined in the framework of "new TQM".

In the "Framework of new TQM", the "Leadership of Top management" is located in the centre of **Figure 3** and "Quality assurance", "Quality improvement", "Static risk management" and "Dynamic risk management" are located in the circumference.

- **Process quality of top management:** The quality of leadership of top management.
- **Process of quality assurance:** Management quality of quality assurance for the primary quality as shown in **Table 2** of product and process that has defined according to the contract with customers.
- **Process of quality improvement:** Management quality of quality improvement for the secondary quality as shown in **Table 2** of system product and process that has been realized.
- **Process of static risk management:** It is the target domain called risk management conventionally. Static risk as shown in **Table 2** may cause future problem by the influenced from current problems or issues of product or process.
- **Process of dynamic risk management:** It is the target domain called investment management or project management conventionally. The management of the investment dynamic risk as shown in **Table 2** is generally handled by dynamic risk management of projects included in the scope of PMBOK (Project Management Body of Knowledge) [14].

## 3. Concept of Target Entity

### 3.1. View Point of Product Quality Assessment

**Figure 4** shows the concept of "Three-Dimensional Unification Value Model (TDUVM)" [13] for a system product quality assessment based on the consideration of expanding ISO/IEC9126 System product quality model.

In this model, three kinds of characteristics such as the "value, performance and adaptability" for the assessment of product quality management of organizations is defined. In this model, three axes correspond to the three characteristics of system product. Also, these three axes are corresponds to the products of PDC cycle as shown in **Figure 1**.

- **Value axis：**

The "value axis" is represents the value of system product such as the supplied function or service for specific context of use. In this paper, the characteristic associated with the "value axis" is the amount of value, which is the capability of organization to have the real value to achieve ultimate objective such as increasing of sustainable development and substantial value of organizations.

- **Performance axis:**

The "performance axis" is representing the capability of organization, which is the capability of organization to realize or maintain the defined value.

- **Adaptability axis:**

The "adaptability" is the capability of adaptation of organization which corresponds to changing the business environment of space or time. Unless the organization is able to adapt to the changes in the business environment, the organization cannot necessarily provide continuously the same amount of value. Therefore, capability of how well an organization can adapt to these changes is defined as "adaptability axis".

The "value axis" and "performance axis" should be differentiated because "excellent performance" may not achieve "excellent value" necessarily. For example, strong or intelligent person cannot be always gentleman.

From **Figure 4**, the overall process management quality of organization can be represented by the volume of the cuboids or vector formed by the "value axis", "performance axis" and "adaptability axis" quantitatively.

### 3.2. View Point of Process Quality Assessment

**Figure 5** shows the concept of "Three-Dimensional Unification Value Model (TDUVM)" for assessment a management quality of process from the consideration of basic concept of the quality control as shown in **Figure 1**.

In this model, the three kinds of viewpoints such as "Planning, Doing and Checking" for a process quality assessment of organizations has defined. In this model, the three kinds of viewpoint correspond to the three axes of process quality. Also, these three axes are corresponds to the process of PDC cycle shown in basic concept of the quality control.

- **Planning axis:**

Planning process is that defining suitable targeted values. The "Planning axis" is the quality of planning process in order to make suitable plan that can achieve ultimate goral such as purpose, objective, schedule and budget.
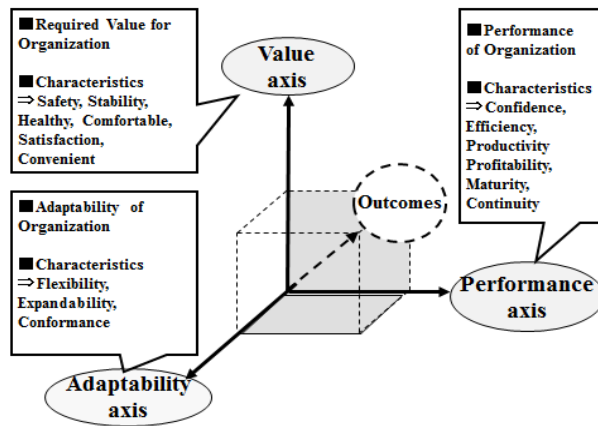
- **Doing axis (Execution):**

**Figure 4.** Concept of Three-Dimensional Unification Value Model for product.
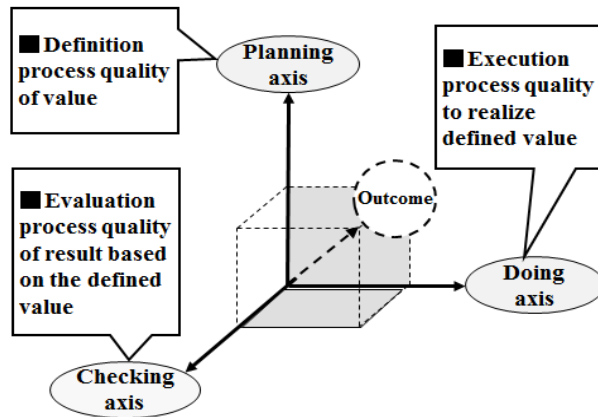


**Figure 5.** Concept of Three-Dimensional Unification Value Model for process.

Execution process is that achieve defined plan. The "Doing axis" is the quality of execution process to achieve objectives of defined plan.

• **Checking axis (Evaluation):**

Evaluation process is that confirm suitable result.

The "Checking axis" is the quality of evaluation process to take suitable result from evaluation based on the defined plan.

From **Figure 5**, total quality of management process of organization can be unified by volume of the cuboids or vector by using "Planning, Doing and Checking axes".

## 4. Verification of Target Entities

**Table 1** show the result of verification of target entities for both product and process quality assessment.

**Table 1** has constructed by the consideration of "framework of new TQM", and viewpoints of "Three-Dimensional Unification Value Models". Also, table1 shows the result of comparison between "proposed whole target entities" and target entities of assessment of conventional AMB (American Malcolm Baldrige for Performance Excellence)".

### 4.1. Target Entities of Product Management

From **Table 1**, it is confirmed that the four kinds of target domains such as "Input, Outcomes, Constrain and Resources" of the "framework of new TQM" include the target entities of AMB. From table1, the scope of pro-

**Table 1.** Comparison between target entities of new TQM and AMB.

| Target Domain of New TQM | View Point of TDUVM | | | Target Entities of Total Quality Management | |
| --- | --- | --- | --- | --- | --- |
| | Value | Performance | Adaptability | Target Entities of Quality Assessment Based on the Proposed New TQM & Three Dimensional Unification Value Models | AMB Target Entities of Quality Assessment of American Malcolm Baldrige Criteria for Performance Excellence (2013-2014) |
| **Input:** for organization | • | | | • Value of input resources | ----- |
| | | • | | • Capability of input resources | |
| | | | • | • Adaptability of input resources | |
| **Outcomes:** of organization | • | | | • Value of outcome resources<br>• Result of improvement of value | Results (Category 7)<br>7.1 Product and Process Result<br>7.2 Customer-Focused Result<br>7.3 Workforce-Focused Result<br>7.4 Leadership and Governance Result<br>7.5 Financial and Market Result |
| | | • | | • Capability of outcome resources<br>• Result of improvement of capability | |
| | | | • | • Adaptability of outcomes<br>• Result of improvement of adaptability | ----- |
| **Constrains:** Limitation of organization from an inside or outside need | • | | | • Limitation from a strategy and rule<br>• Limitation from needs<br>• Limitation of schedule & budget | Strategic Planning (Category 2)<br>2.1 Strategy Development 2.2 Strategy Implementation<br>Customer Focus (Category 3)<br>3.1 Voice of the Customer 3.2 Customer Engagement |
| | | • | | • Limitation of capability of resources | Measurement, Analysis, and Knowledge Management (Category 4) 4.2 Management of Information, Knowledge, and Information Technology Workforce Focus (Category 5)<br>5.1 Workforce Environment<br>5.2 Workforce Engagement<br>Operations Focus (Category 6)<br>6.1 Work Processes<br>6.2 Operational Effectiveness |
| | | | • | • Limitation of adaptability of resources | ----- |
| **Resources:** Infrastructure of organization | • | | | • Value of inner company resources | Measurement, Analysis, and Knowledge Management (Category 4)<br>4.1 Measurement, Analysis, and Improvement of Organizational Performance<br>4.2 Management of Information, Knowledge, and Information Technology<br>Workforce Focus (Category 5)<br>5.1 Workforce Environment<br>5.2 Workforce Engagement |
| | | • | | • Capability of inner company resources<br>• Suitability of inner company resources<br>• For example, inner companies shared service | |
| | | | • | • Adaptability of inner company resources | ----- |

*(Left margin rotated label: Product — spanning Constrains and Resources rows. Bottom rotated labels under view point columns: Planning, Doing, Checking)*

**Continued**

| Process | | | | |
|---|---|---|---|---|
| **Leadership** of top management | • | • Good sense of values, public spirit, originality, intelligence, decision making, strategic planning | Leadership (Category 1) 1.1 Senior Leadership 1.2 Governance and Societal Responsibilities Strategic Planning (Category 2) 2.1 Strategy Development 2.2 Strategy Implementation | |
| | • | • Good sense of responsibility, ability for self-act, leadership, strategic control, communication | | |
| | • | • Fairness, outlook on ethic, accountability | | |
| **Quality Assurance** | • | • Quality of planning process | Measurement, Analysis, and Knowledge Management (Category 4) 4.1 Measurement, Analysis, and Improvement of Organizational Performance Operations Focus (Category 6) 6.1 Work Processes 6.2 Operational Effectiveness | |
| | • | • Quality of execution process | | |
| | • | • Quality of evaluation process | | |
| **Quality Improvement** | • | • Quality of Planning process | | |
| | • | • Quality of execution process | | |
| | • | • Quality of evaluation process | | |
| **Static Risk Management** | • | • Quality of planning process | ----- | |
| | • | • Quality of execution process | | |
| | • | • Quality of evaluation process | | |
| **Dynamic Risk Management** | • | • Quality of planning process | ----- | |
| | • | • Quality of execution process | | |
| | • | • Quality of evaluation process | | |

posed target entities is wider than the target entities of conventional AMB (American Malcolm Baldrige for Performance Excellence).

Also, some duplication and confusion of target entities are recognized in AMB.

From **Table 1**, the target entities of AMB such as "input, constrain and resources" are weak than the outcomes.

Furthermore, lack of the viewpoints of target entities such as "Value, Performance and Adaptability" for product assessment is recognized in AMB.

## 4.2. Target Entities of Process Management

From **Table 1**, the five kinds of target domains for process assessment such as "Leadership of Top Management, Quality Assurance, Quality Improvement, Static Risk Management and Dynamic Risk Management" of the "frame work of new TQM" include the target entities of AMB. Also, the three kinds of viewpoints such as the "Planning, Doing and Checking" for process assessment defined in "Three-Dimensional Unification Value Model" include target entities of AMB.

On the other hand, lack of the target domains for process assessment for TQM such as "Static Risk Management and Dynamic Risk Management" is recognized in AMB. Furthermore, lack of the view point of target entities such as "Planning, Doing and Checking" for process assessment is recognized in AMB.

## 5. Conclusions

In this study, we suggested the whole target entities of TQM based on the consideration of the view point of "new TQM" and "Three-Dimensional Unification Value Model" in order to cover total quality assessment.

Also, we verified the correctness of suggested whole target entities of TQM based on the study of comparison between proposed target entities and AMB as shown in **Table 1**. Furthermore, we suggested that it is also necessary to separate the target entities of TQM from the viewpoint of "product and process" quality assessment shown in **Table 1**. For the purpose of improvement of management quality, it is necessary to improve not only the process quality but also product quality such as the "input, outcomes, constrain and resources".

**Table 2.** Explanation of terminology.

| Explanation of Terminology | Product<br>Input or Outcomes recourses of process. Product is a result of activity such as planning, development, evaluation. | Process<br>Conversion process from input resources into outcomes resources. A process is a procedure or method of the activities. |
|---|---|---|
| **Quality:**<br>The whole of the quality of a product and process about the ability to satisfy stated or implied needs. Objects of a quality control usually are quality of product and quality of process. Quality is defined to the primary quality, secondary quality and quality in use defined in ISO/IEC25000. | From ISO, terminology "Product Quality" is defined as "totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs". "System product quality" is defined in six characteristics in ISO/IEC9126 (ISO/IEC25010) quality models. | "Process quality" is the efficiency of conversion process from input resources into outcomes and that is evaluated by following equation.<br>process quality = quality of outcomes re-sources/quality of input resources<br>For example, process quality can be assured from the view points as follows.<br>Does PDC cycle rotate?<br>To satisfy ISO9000 requirements? |
| **Primary Quality:**<br>Quality to meet specified requirements. | A product quality meets quality requirement specification of product. | A process quality meets quality requirement specification of process. Example of requirement specification of process is as follows.<br>Rules of company or international standard. |
| **Secondary Quality:**<br>An expected quality of product and process. | An attractive product quality to meet a tacit expectation of customer needs. | An effective process quality to meet a tacit expectation of stakeholders needs. |
| **Cause:**<br>A reason that causes a problem or issue. | The reason that causes a problem of product such as a defect, fault, error, obstructs. | The reason that causes a problem of process such as a quality decline, excess over the cost, an appointed date of delivery delay. |
| **Problem**:<br>An abnormal status of product or process. The state that cannot realize primary quality. Problems can be finally zero if we push forward correction. | An abnormal status of product that is deviated from quality requirement specification of product.<br>For example, a problem of product is such as a defect, a fault, an error, an obstacle, etc. | An abnormal status of process that is deviated from quality requirement of process.<br>For example, it is not to meet the process requirements of ISO9000 or rules of the inner or outer organization. |
| **Issue:**<br>An expected status of product or process. The status that cannot be second quality. An issue never disappears. | An expected status of a product which want to be improved in a more attractive quality. It is necessary to soak a priority depending on importance and urgent degree, and to push forward improvement of product. | A prospective quality of process that want to be improved more efficiently. It is necessary to soak a priority depending on importance and urgent degree, and to push forward improvement of process. |
| **Static Risk:**<br>Outbreak probability and the scale of the loss. | The loss that may occur in future by leaving an inner or outer problem or issue of product | The loss that may occur in future by leaving an inner or outer problem or issue of process. |
| **Dynamic Risk:**<br>Outbreak probability and the scale of an effect or loss. For example, dynamic risk management is necessary for investment or project management. | An expected effect or loss that may occur in the future by an activity for the resolution of problem of product. | An expected effect or loss that may occur in the future by an activity for the resolution of problem of process. |

The target entities of product quality of "input" are necessary for product quality assessment as shown in **Table 1**. Because, it is very important to evaluate process management quality how much you lead the best outcomes from limited input resources.

Also, the characteristics of target entities such as "Value", "Performance" and "Adaptability" should be separated for product quality assessment.

Because, the performance is means and it is not a purpose of values. We should not mistake a purpose for means.

Furthermore, the definition of value is most important for product quality assessment during the planning process because the Value is very important in order to achieve objective of management successfully.

On the other hand, for the offering stable value to customers continuously, process quality assessment of target domains such as "dynamic crisis control and the static crisis control" from long range outlook is necessary, and to grow up continuously.

Also, the view point of target entities such as the "Planning, Doing and Evaluation" for process quality assessment should be separated as shown in **Table 1**. Furthermore, the planning process quality is most important in order to define the purpose of value. Because, the purpose cannot be achieved successfully if quality of planning is bad even if execution process is good, and the loss occurs.

In the future study, we plan the empirical study of new TQM more detail and measurement methods by each assessment target entities and will verify them.

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