Process Dynamics, Variations and Controls in Software Engineering

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Background

- Business operations are always under the influence of variations due to change in customer needs, market demands, internal processes and technology upgrades. These changes have direct impact on the performance of IT processes cascading down to the quality of products/services. In order to mitigate the adverse effects due to the variations of the aforementioned, organizations need to understand the concepts of software process dynamics and process controls

- Variations in IT processes are due to the factors affecting the process equilibrium. These factors are often not sensitive to the enforced process controls. This paper focuses on how the understanding of process variation and controls are useful in sustaining and improving process capability

- This paper concentrates on the theory of software process dynamics and process variation including the importance of process controls to ensure process equilibrium. This paper discusses the degree of association between Process and Quality through a Process Quality Relationship (PQR) Matrix that helps in managing the processes and sustaining the product/service quality

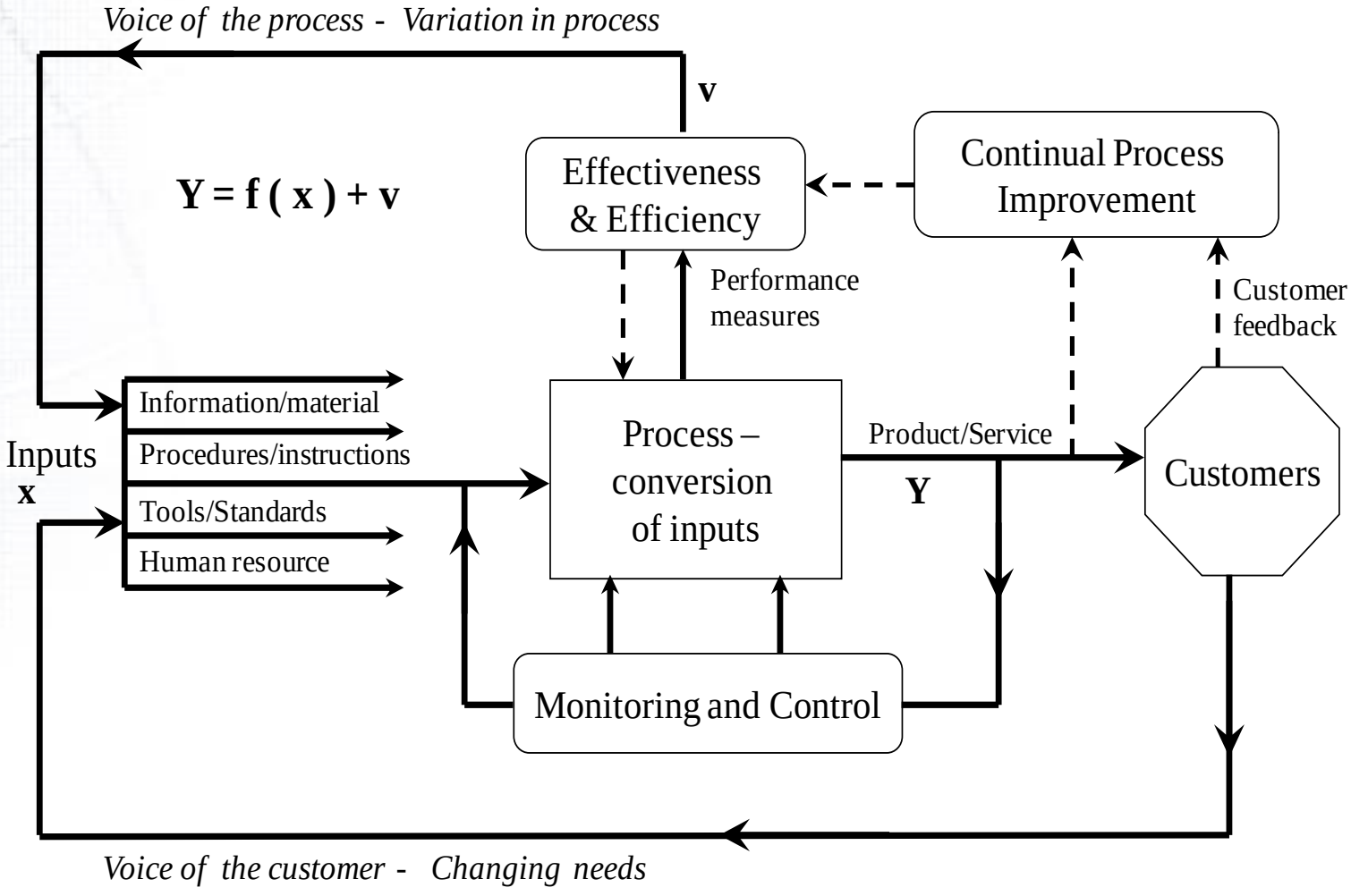
Introduction

- Processes are critical entities in an organization and its operational success is tied with the effective performance of the processes
- The biggest challenge for the organizations is to act on the customer requirements and translate them into product/service with agreed quality attributes at low cost
- Factors affecting process stability:
  - Combined effects of schedule targets
  - Communication overhead
  - Changing business conditions
  - Requirements volatility
  - People experience
  - Work methods such as reviews and quality assurance activities
  - Task underestimation and organizational shifts

To mitigate the adverse effects due to variation, organizations need to focus on understanding the process dynamics and causes of variation to establish effective processes and adequate controls.

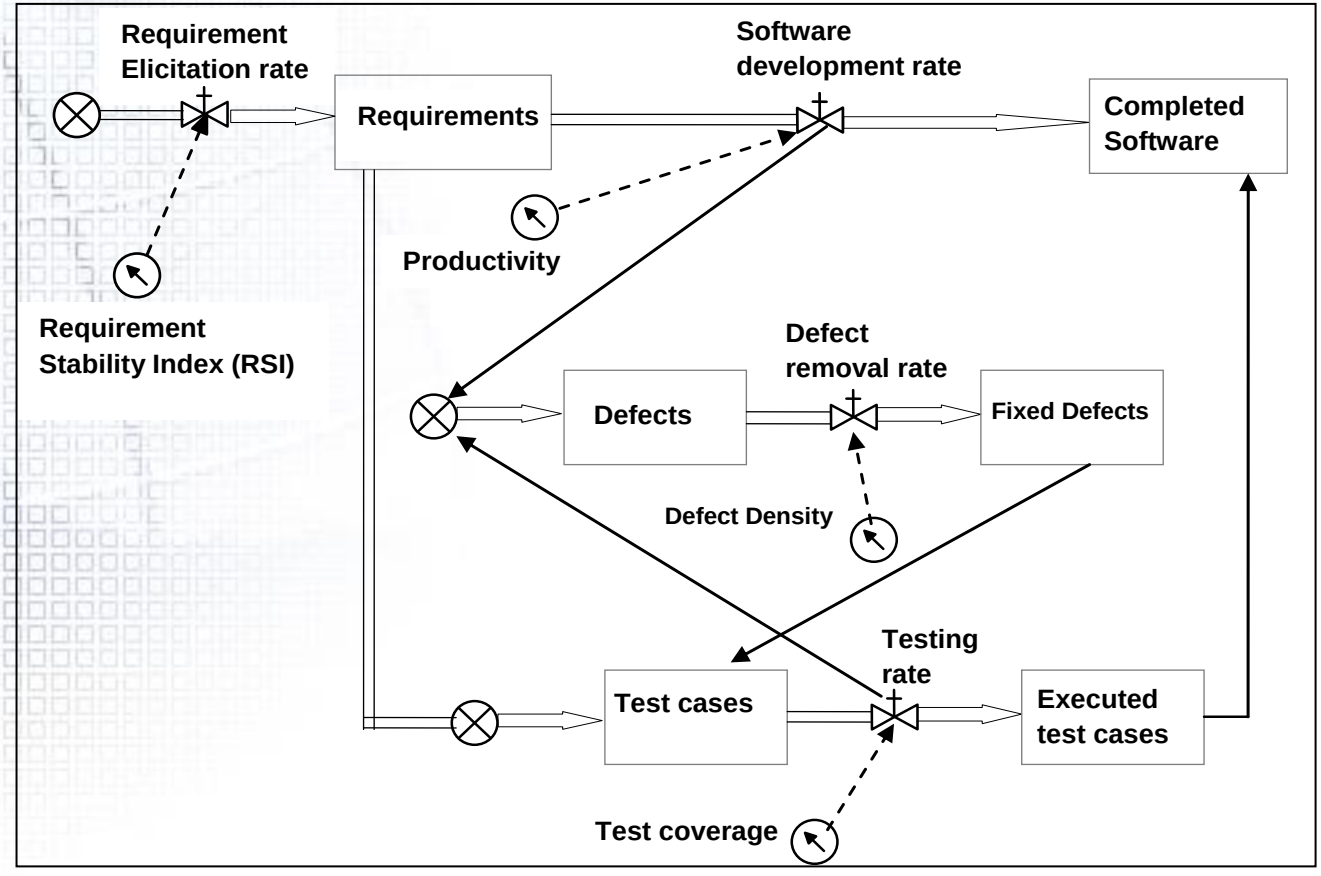
Introduction (cont…)

Closed loop process mechanism



Software process dynamics model

The following schematic diagram represents a simple process dynamics model for software development and its interrelated sub-process components



The relationship between parent and sub-processes can be expressed in terms of a theoretical equation:

$$\sum_{i=1}^{n} Pdy_i = pdy_1 + pdy_2 + pdy_3 + ... + pdy_n$$

Where,

$\sum$ **Pdy** is overall process dynamics,

$pdy_1 + pdy_2 + pdy_3 + ... + pdy_n$ are process dynamics of each sub-process and

n is number of sub-processes

Input entry point

Data flow

Process execution rate

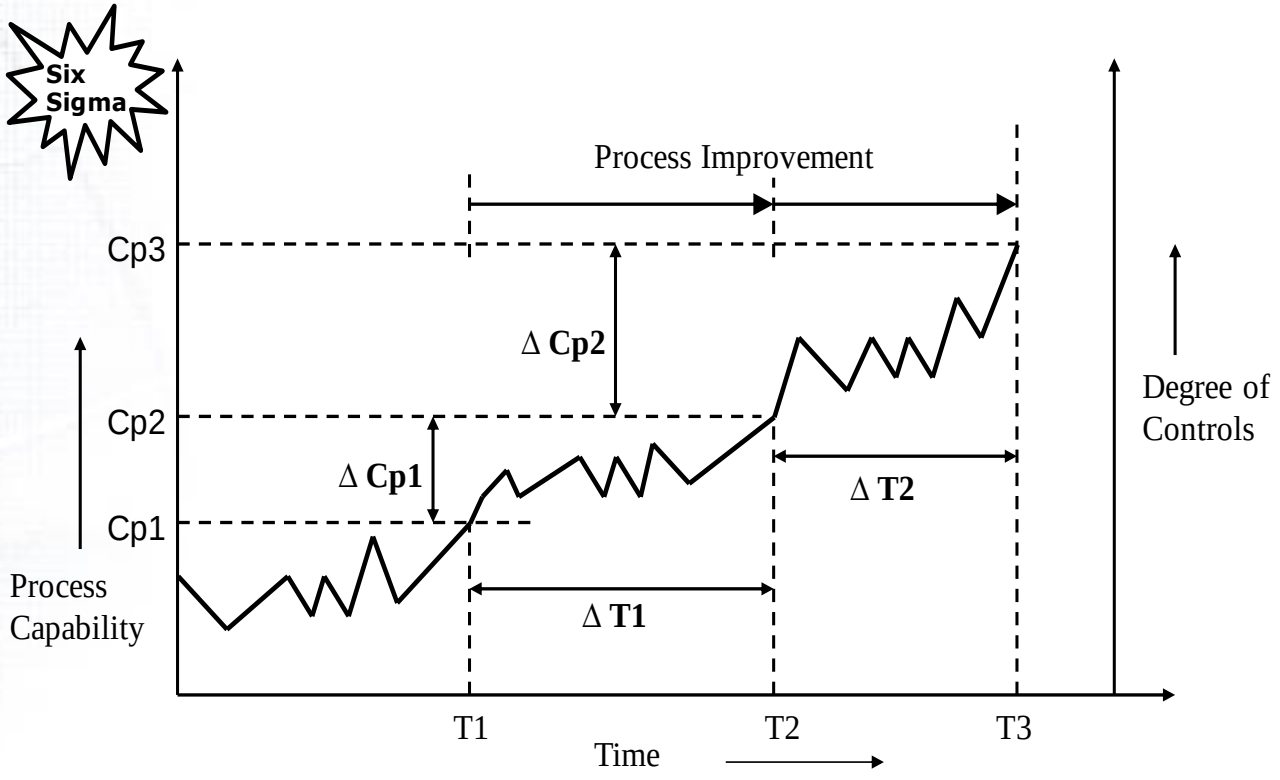
Performance measurement

Sub-process bin

Feedback loops

Process capability versus process controls

The following diagram depicts the association between incremental process capability, process improvement and degree of controls



Δ Cp = f (process control × process improvement) × Δ T + inherent process variation

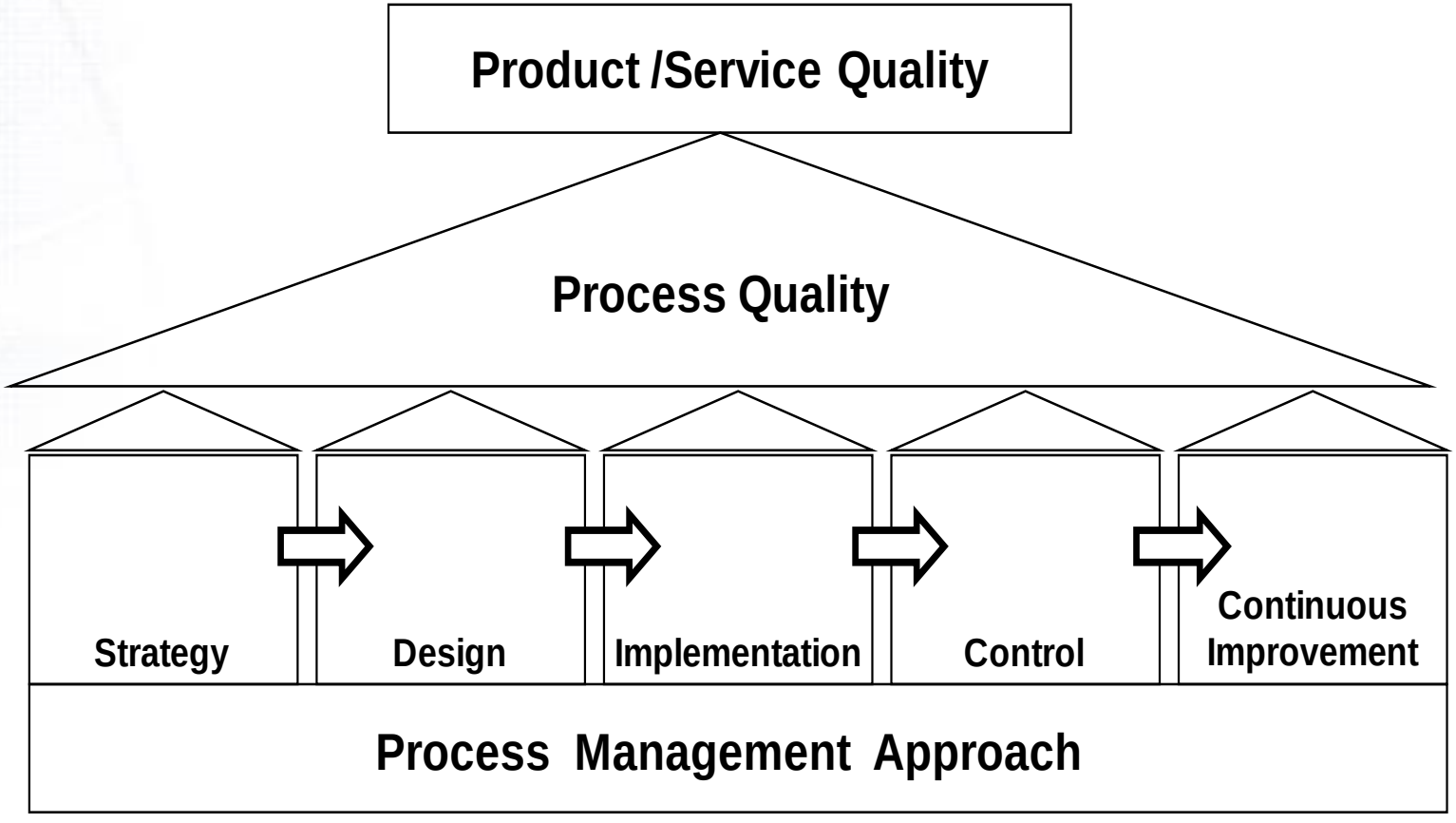
Where,

Δ **Cp** = Change in process capability over a time period, (for example, Δ **Cp1** = Cp2 value at T2 – Cp1 value at T1)

Δ **T** = Change in time period (for example, Δ**T1** = T2 – T1)

SDICC- Approach for Process Management

A structured approach for effective process management consisting of five components (abbreviated as SDICC): Strategy; Design; Implementation; Control; and Continuous Improvement



Components of SDICC

SDICC Component	Description
Strategy	Process strategy is the pattern of decision making in identification, selection and managing of processes so that they will achieve their competitive priorities and build business value through process improvement
Design	Based on the result of process strategy, the prioritized and selected processes are designed to meet the process objectives and thereby enable the organization to achieve the business and customer needs
Implementation	Initial process implementation is piloted on selected areas to ensure adequacy of the process design to enable subsequent process refinement before implementing across the organization. Process owners and performers should be aware of the purpose, objectives and outcomes of the process along with the relevant measurements to be captured during implementation
Control	The primary objective of process control is to track process performance against expected results and maintain steady performance. The adequacy and degree of controls should be derived considering the stability and capability of the process
Continuous Improvement	The analysis results from Process control provide opportunities for process improvement initiatives. Improvement opportunities identified with an objective to eliminate the causes or to reduce the effect of causes depending upon nature of the problem

Process Quality Relationship (PQR) Matrix

Process Management Components →

Juran Quality Trilogy ↓	Strategy	Design	Impleme-ntation	Control	Continuous improvement
Quality Planning	3	5	3	1	5
Quality Control	1	5	3	5	3
Quality Improvement	5	3	1	3	5

1 Weak 3 Moderate 5 Strong

The numbers represent the degree of association between quality and process components

- The PQR matrix reveals the fact that, in totality the components of the quality trilogy across the process management components have equal importance though they have varied one-to-one degrees of association.

- The relationship scores along the rows for Quality Planning (3+5+3+1+5), Quality Control (1+5+3+5+3) and Quality Improvement (5+3+1+3+5) all total 17.

  - This depicts the need of the attention of process practitioners for considering and ingraining the quality aspects while defining and managing the processes to achieve the set process objectives and quality outputs

- Considering the relationship scores (columns) for each of the process components, the scores for Process Design and Process Improvement have 13 for each and are highest as compared to others (Process Strategy = 9, Process Implementation=7, Process Control= 9).

  - This indicates that process design and improvements need more focused attention towards quality trilogy elements during process definition and modelling

PQR Table

The association of quality and process management evaluated based on their interactions and explained in the below table

Quality and Process components	Degree of association	Description
Quality Planning and Process Strategy	Moderate	The decisions on process identification and selection are primarily driven by the business needs and high level customer requirements. The requirements are not mature enough for detail quality planning while formulating process strategy.
Quality Planning and Process Design	Strong	Process objectives are formulated and aligned with the quality objectives which are derived from customer and business needs and processes are designed by defining the means to meet those objectives
Quality Planning and Process implementation	Moderate	The defined processes are implemented and performed to meet the planned process and quality objectives. Process implementation should ensure achievement of these objectives.
Quality Planning and Process Control	Weak	The outcome of process monitoring and control trigger the actions for bringing the process back on track in case of variations but process and quality objectives are not changed unless there is a change in customer and business needs
Quality Planning and Process Improvement	Strong	Improvements are initiated to enhance the process maturity level based on the performance results and accordingly the process and quality objectives are revisited in line with customer and business needs.

PQR Table (Contd...)

Quality and Process components	Degree of association	Description
Quality Control and Process Strategy	Weak	The feedback on effectiveness of performed processes in achieving the objectives triggers process improvement initiatives but not the revisit of process strategy.
Quality Control and Process Design	Strong	Appropriate process measures for tracking and evaluating the actual process and quality performance are addressed during process design. These measurements trigger the actions against the deficiencies between expected and actual performance.
Quality Control and Process implementation	Moderate	The effectiveness of process implementation is measured in terms of achievement of process and quality objectives. Effective implementation is ensured by taking appropriate corrective and preventive actions.
Quality Control and Process Control	Strong	The identified Process and Quality control measures are complimentary to each other and evaluated against the process and quality objectives during the course of process execution
Quality Control and Process Improvement	Moderate	Analysis results on outcome of the Quality control activities are the sources for the potential process improvements.

PQR Table (Contd...)

Quality and Process components	Degree of association	Description
Quality Improvement and Process Strategy	Strong	Identification and initiation of specific improvement projects to enhance the operational efficiency provides inputs for development of new processes and revisit of organization process strategy.
Quality Improvement and Process Design	Moderate	The planned process and quality improvement objectives are addressed while designing the process along with appropriate performance measures.
Quality Improvement and Process Implementation	Weak	Beneficial change oriented processes are implemented through systematic quality improvement plans. Contributions towards quality improvement during process implementation is very low
Quality Improvement and Process Control	Moderate	The revised process and quality objectives are evaluated and controlled through appropriate corrective and preventive actions
Quality Improvement and Process Improvement	Strong	Both Process and quality improvement are complementary with each other and contribute equally in achieving organization goals. Both share inputs and outputs with each other.

Conclusion

- While designing and managing the processes for an organization, it is very much necessary to address quality factors right from the process inception to its institutionalization

- The relationship between process capability, control and improvement was presented to demonstrate that incremental change in process capability is a time dependent function of process control and process improvement

- Characterization of process variation discloses the pattern and nature of the variation which helps the process improvement teams in initiating improvement tasks.

- The proposed SDICC approach based on the Juran quality trilogy model, helps process practitioners in design of new processes and improve existing process performance..

- The relationship between process and quality established through a PQR Matrix demonstrated the importance of Juran quality trilogy components and their association with process management components

Thank You