Project Execution, Monitoring and Control

Topics of the lecture as follows:

- PDCA cycle
- Project execution processes by PMBOK
- Project monitoring and controlling processes by PMBOK
- Project monitoring and controlling processes in RUP and agile approaches
- Project vital signs

PDCA Cycle

Management processes (concerning also projects) are based on PDCA cycle model:

- PLAN: design or revise a process to achieve the desired results
- DO: implement the plan and measure its performance
- CHECK: analyze the metrics and review the results
- ACT: decide what changes are needed to improve the process

This cycle is shown on the next figure:

![PDCA Cycle Diagram](image)

**Figure 1. PDCA Cycle**

In the context of information system development it means:

- planning is design or revise a information system development process to achieve the desired information system
- doing is developing information system and measuring its performance
- checking is analyzing of metrics and reviewing development results
- acting is deciding what changes are needed to improve development process

Pictorially expressed on the next figure:

![PDCA Cycle in the Context of Information System Development](image)

**Figure 2. PDCA Cycle in the Context of Information System Development**

### Project Execution, Monitoring and Control

PDCA cycle processes are presented also in PMBOK. To planning are corresponding project planning processes (planning process group); to doing are corresponding executing processes (executing processes group); to checking and acting are corresponding monitoring and controlling processes (monitoring and controlling process group). Relationships between these process groups through corresponding inputs and outputs are presented on the next figure. Semantics of abbreviations used on the figure are as follows:

- **PM Plan** – project management plan
- **OPA** – organizational process assets
- **EEF** - enterprise environmental factors
- **WPI** – work performance information
- **CR** – change request
- **QCM** – quality control measurements
Figure 3. Relationships between Project Process Groups
Project execution processes holds in accordance process named “direct and manage project execution”. Monitoring of project performance holds in accordance process named “monitor and control project work”. Changes regarding all manageable aspects in project holds in accordance process named “perform integrated change control”. All these mentioned processes are subject of this lecture.

Project Execution Processes
The Executing Process Group consist of those processes performed to complete the work defined in the project management plan to satisfy the project specifications. This Process Group involves coordinating people and resources, as well as integrating and performing the activities of the project in accordance with the project management plan. During project execution, results may require planning updates and re-baselining. This can include changes to expected activity durations, changes in resource productivity and availability, and unanticipated risks. Such variances may affect the project management plan or project documents and may require detailed analysis and development of appropriate project management responses. The results of the analysis can trigger change requests that, if approved, may modify the project management plan or other project documents and possibly require establishing new baselines

All execution processes in Project Execution Process Group are presented on the next figure:
In the centre of these processes is directing and managing project execution. Its responsibility is to ensure that planned work gets done.

**Direct and Manage Project Execution**

Direct and Manage Project Execution is the process of performing the work defined in the project management plan to achieve the project's objectives. The project manager, along with the project management team, directs the performance of the planned project activities, and manages the various technical and organizational interfaces that exist within the project. This process is directly affected by the project application area. Deliverables are produced as outputs from processes performed to accomplish the project work planned and scheduled in the project management plan. Work performance information, about the completion status of the deliverables and what has been accomplished, is collected as part of project execution and is fed into the performance reporting process. The work performance information will also be used as an input to the Monitoring and Controlling Process Group.

Process activities include, but are not limited to:

- perform activities to accomplish project requirements;
- create project deliverables;
- staff, train, and manage the team members assigned to the project;
- obtain, manage, and use resources including materials, tools, equipment, and facilities;
- implement the planned methods and standards;
- establish and manage project communication channels, both external and internal to the project team;
- generate project data, such as cost, schedule, technical and quality progress, and status to facilitate forecasting;
- issue change requests and adapt approved changes into the project’s scope, plans, and environment;
- manage risks and implement risk response activities;
- manage sellers and suppliers; and
- collect and document lessons learned, and implement approved process improvement activities.

Direct and Manage Project Execution also requires implementation of approved changes covering:

- **Corrective action.** Documented direction for executing the project work to bring expected future performance of the project work in line with the project management plan.
- **Preventive action.** A documented direction to perform an activity that can reduce the probability of negative consequences associated with project risks.
- **Defect repair.** The formally documented identification of a defect in a project component with a recommendation to either repair the defect or completely replace the component.

Direct and manage project work process inputs and outputs are presented on the next figure:

**Figure 5. Project Execution Inputs and Outputs**

Links to monitoring and controlling processes are presented on the next figure:
Figure 6. Relationships between Executing and Monitoring and Controlling Processes

Organizational Process Assets (OPA)

- standardized guidelines and work instructions;
- communication requirements defining allowed communication media, record retention, and security requirements;
- issue and defect management procedures defining issue and defect controls, issue and defect identification and resolution, and action item tracking;
- process measurement database used to collect and make available measurement data on processes and products;
- project files from prior projects (e.g., scope, cost, schedule, performance measurement baselines, project calendars, project schedule, network diagrams, risk registers, planned response actions, and defined risk impact);
- issue and defect management database containing historical issue and defect status, control
- information, issue and defect resolution, and action item results

Work Performance Information (WIP)

Gathering and analysis of work performance information is essential to the project management plan and should be considered a priority. Work performance information contributes to the efficient use of resources, identifies potential trouble spots and problems, and serves as an effective project management tool. It is useful as input data for quality control measures and programs. WIP can include following data items:

1. Projects and project data
2. Project progress
3. Project status
4. Project risks
5. Project issues
6. Project metrics
7. Project documents
8. Project lessons learned
9. Project change requests
10. Project risk assessments
11. Project risk responses
12. Project risk audits
13. Project risk reports
14. Project risk register
15. Project risk register update
16. Project risk register closure
17. Project risk register review
18. Project risk register evaluation
19. Project risk register analysis
20. Project risk register monitoring
21. Project risk register control
22. Project risk register communication
23. Project risk register action
24. Project risk register action planning
25. Project risk register action implementation
26. Project risk register action monitoring
27. Project risk register action control
28. Project risk register action communication
29. Project risk register action action
30. Project risk register action planning
31. Project risk register action implementation
32. Project risk register action monitoring
33. Project risk register action control
34. Project risk register action communication
35. Project risk register action action
36. Project risk register action planning
37. Project risk register action implementation
38. Project risk register action monitoring
39. Project risk register action control
40. Project risk register action communication
41. Project risk register action action

- status information on schedule progress
- whether deliverables have been completed, or not
- start and finish status of schedule activities
- quality standards expectation results
- authorized costs vs. costs incurred to date
- estimated completion time for scheduled activities in progress
- percentage of physical completion of in-progress schedule activities
- experience based knowledge acquired, documented, and posted to knowledge base
- details of resource utilization

**Monitoring and Controlling Processes**

The Monitoring and Controlling Process Group consists of those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes. The key benefit of this Process Group is that project performance is observed and measured regularly and consistently to identify variances from the project management plan. The Monitoring and Controlling Process Group also includes:

- controlling changes and recommending preventive action in anticipation of possible problems,
- monitoring the ongoing project activities against the project management plan and the project performance baseline, and
- influencing the factors that could circumvent integrated change control so only approved changes are implemented

This continuous monitoring provides the project team insight into the health of the project and identifies any areas requiring additional attention. The Monitoring and Controlling Process Group not only monitors and controls the work being done within a Process Group, but also monitors and controls the entire project effort. In multi-phase projects, the Monitoring and Controlling Process Group coordinates project phases in order to implement corrective or preventive actions to bring the project into compliance with the project management plan. This review can result in recommended and approved updates to the project management plan. For example, a missed activity finish date may require adjustments to the current staffing plan, reliance on overtime, or trade-offs between budget and schedule objectives.

Project monitor and control processes are presented on the next figure:
In the centre of project monitor and control are 2 processes: *monitor and control project work* and *perform integrated change control*. These processes are mutually related through change request life cycle management.

**Monitor and Control Project Work**

Monitor and Control Project Work is the process of tracking, reviewing, and regulating the progress to meet the performance objectives defined in the project management plan. Monitoring includes status reporting, progress measurement, and forecasting. Performance reports provide information on the project’s performance with regard to scope, schedule, cost, resources, quality, and risk, which can be used as inputs to other processes. Monitor and Control Project Work is the process of tracking, reviewing, and regulating the progress to meet the performance objectives defined in the project management plan. Monitoring is an aspect of project management performed throughout the project.

Monitoring includes collecting, measuring, and distributing performance information, and assessing measurements and trends to effect process improvements. Continuous monitoring gives the project management team insight into the health of the project, and identifies any areas that may require special attention. Control includes determining corrective or preventive actions or replanning and following up on action plans to determine if the actions taken resolved the performance issue.

The Monitor and Control Project Work process is concerned with:

- Comparing actual project performance against the project management plan;
- Assessing performance to determine whether any corrective or preventive actions are indicated, and then recommending those actions as necessary;
• Identifying new risks and analyzing, tracking, and monitoring existing project risks to make sure the risks are identified, their status is reported, and that appropriate risk response plans are being executed;

• Maintaining an accurate, timely information base concerning the project’s product(s) and their associated documentation through project completion;

• Providing information to support status reporting, progress measurement, and forecasting;

• Providing forecasts to update current cost and current schedule information; and

• Monitoring implementation of approved changes as they occur.

Inputs and outputs of this process are presented on the following figure:

![Figure 8. Project Work Monitor and Control Inputs and Outputs](image)

Figure 8. Project Work Monitor and Control Inputs and Outputs

Relationships with other processes are shown on the next figure:
This subject will be covered more detailed in a separate lecture.

**Performance Reports**

Reports should be prepared by the project team detailing activities, accomplishments, milestones, identified issues, and problems. Performance reports can be used to report the key information including, but not limited to:

- current status
- significant accomplishments for the period
- scheduled activities
- forecasts
- issues

**Organization Process Assets**

Available organizational process assets for monitoring and control of project work can be as follows:

- organization communication requirements,
• financial controls procedures (e.g., time reporting, accounting codes, expenditure and disbursement reviews, and standard contract provisions)
• issue and defect management procedures
• risk control procedures including risk categories, probability definition and impact, and probability and impact matrix,
• process measurement database used to make available measurement data on processes and products
• lessons learned database

Perform Integrated Change Control

It is the process of reviewing all change requests; approving changes and managing changes to the deliverables, organizational process assets, project documents and the project management plan. This process is conducted from project inception through completion. The project management plan, the project scope statement, and other deliverables are maintained by carefully and continuously managing changes either by rejecting changes or by approving changes. Thereby assuring that only approved changes are incorporated into a revised baseline.

Perform integrated change control process inputs and outputs are presented on the next figure:

Figure 10. Perform Integrated Change Control Inputs and Outputs

This subject is also more detailed covered in a separate lecture.

As a summary of project execution, monitoring and controlling processes in PMBOK a following table is presented showing concrete processes of each aspect or knowledge are.
Table 1. Executing & Monitoring & Controlling Processes over Aspects

<table>
<thead>
<tr>
<th>Management aspect</th>
<th>Executing processes</th>
<th>Monitoring &amp; controlling processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration</td>
<td>Direct and Manage Project Execution</td>
<td>Monitor and Control Project Work</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Perform Integrated Change Control</td>
</tr>
<tr>
<td>Scope</td>
<td></td>
<td>Verify Scope</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control Scope</td>
</tr>
<tr>
<td>Time</td>
<td></td>
<td>Control Schedule</td>
</tr>
<tr>
<td>Cost</td>
<td></td>
<td>Control Costs</td>
</tr>
<tr>
<td>Quality</td>
<td>Quality Assurance</td>
<td>Quality Control</td>
</tr>
<tr>
<td>Human Resource</td>
<td>Acquire Project Team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Develop Project Team</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Manage Project Team</td>
<td></td>
</tr>
<tr>
<td>Communications</td>
<td>Distribute Information</td>
<td>Report Performance</td>
</tr>
<tr>
<td></td>
<td>Manage Stakeholder Expectations</td>
<td></td>
</tr>
<tr>
<td>Risks</td>
<td></td>
<td>Monitor and Control Risks</td>
</tr>
<tr>
<td>Procurement</td>
<td>Conduct Procurements</td>
<td>Administer Procurements</td>
</tr>
</tbody>
</table>

Monitor and Control Project in RUP

In RUP it is corresponding workflow named: "Monitor and Control Project". In this workflow project manager does following:

- deals with change requests that have been sanctioned by the Change Control Manager, and schedules these for the current or future iterations;
- continuously monitors the project in terms of active risks and objective measurements of progress and quality;
regularly reports of project status, in the Status Assessment, to the Project Review Authority (PRA), which is the organizational entity to which the Project Manager is accountable;

- deals with issues and problems as they are discovered, through the Activity: Monitor Project Status or otherwise, and drives these to closure according to the Artifact: Problem Resolution Plan. This may require that Change Requests be issued for work that cannot be authorized by the Project Manager alone.

Project manager duties in monitoring and controlling project in RUP are presented on the following figure:

![Project Monitor and Control in RUP](image)

**Figure 11. Project Monitor and Control in RUP**

### Agile Monitoring and Control

Product owner has interest of:

- Progress of Sprint – how team works to accomplish Sprint goals
- Progress of release – will quality and functional release be ready for due date
- Product progress – how product will be ready as needed

To answer these questions we need to assess:
- Product backlog
- Release backlog
- Sprint backlog

To assess backlogs Burn-Down chart – we get
- Trends of backlog
- Team velocity = actual work hours / remaining work hours

Project Vital Signs

Comprehensive method for monitoring, reporting, and taking timely actions to correct problems during IT project. By Gopal K. Kapur - ProjectHALT Methodology

These vital signs are following:
- Status of the Critical Path
- Mileston Hit Rate
- Deliverable Hit Rate
- Issues
- Cost-to-Date vs. Estimated Cost-to-Date
- Actual Resources vs. Planned Resources
- High Probability, High Impact Risk Events
- General Disposition of the Team
- Sponsor's Commitment and Time

Status of the Critical Path

Communicates whether the project is on schedule, ahead of schedule, or behind of it. Delay, what is:
- < 10% - a fairly normal fluctuation from the norm and can usually be recovered with strong guidance from the project manager and focused by the team
- 10% - 20% - problems resulting in the breach of the critical path are beyond the control of the team, and the project manager and the sponsor need to make sure the team has a viable plan to recover the delay
- > 20% - extremely difficult to recover from such delays without compromising the other 3 key components of the project – scope (functionality), budget, and quality. Unless the underlying problems are corrected, the project is sure to continue on its downward slide
Milestone Hit Rate

Indicates the number of milestones the team was planning to hit and the number of milestones they actually hit during a specific reporting period. Methodology authors recommend 2 separate monitoring cycles:

- To-date performance - the total number of milestones planned to be hit vs. The total number of milestones actually hit
- A shorter monitoring cycle - every 2 weeks: the total number of milestones planned to be hit vs. The total number of milestones actually hit

The to-date hit rate tells of the overall speed and progress of the team, and the shorter monitoring cycle indicates the team’s recent progress:

- A gap of 10% to 20% - the team is beginning to fall. Project manager need to review the situation, devise a plan for recovery, and work with the team to ensure it begins to increase its milestone hit rate
- > 20% - there is little progress on the project, the team is barely crawling, it has lost its focus and momentum. This type of slow down is sure to result in considerable delay in the currently promised delivery date of the project

Deliverable Hit Rate

Deliverables tell us about team’s accomplishments. It is important to monitor the team’s accomplishments in terms of deliverables planned for completion versus the number of deliverables actually completed. The failure of the team to maintain a consistent deliverable hit rate suggests that there are deep rooted issues that need to be resolved. 2 separate monitoring cycles:

- To-date performance: the total number of deliverables planned to be completed to-date vs. The total number of deliverables actually completed
- A shorter monitoring cycle – every 4 weeks: the total number of deliverables planned to be completed vs. The total number of deliverables actually completed

The to-date completion rate of deliverables tells about the rate of the “build” of the project, and the shorter monitoring cycle indicates the ongoing progress. The total number of deliverables planned to be completed vs. The total number of deliverables actually completed, what has/is:

- A gap of 10% to 20% - some of the team members are encountering obstacles which are keeping them from finishing their deliverables. Critical path will soon be breached
- > 20% - too many deliverables are remain incomplete or have not yet been started. This could be due to such problems as shortage of resources, lack of appropriate skills, poor specifications, ad hoc change management process, or discovery of new functionality
Cost-to-Date vs. Estimated Cost-to-Date

As the project proceeds down its development path, it is imperative that the actual cost-to-date be compared to the estimated cost. Project manager must carefully monitor any overspending.

If the actual cost-to-date is:
- Between 10% to 20% higher than the estimated cost-to-date
  - The return on investment (ROI) will be affected
  - The benefit to the bottom line will be considerably less than what was promised to the client at the time of original estimates
- > 20% higher than estimated cost
  - The projects actual cost is running at a rate that may fail to return any financial benefits at all

For organizations that do not monitor the total cost, methodology authors suggest capturing Effort-to-Date vs. Estimated Effort-to-Date.

If the actual effort-to-date is:
- Between 10% to 20% higher than the estimated effort-to-date
  - Original estimates were too optimistic, or
  - The team members are discovering complexities they had not forecast at the start of the project, or
  - Work environment is not very productive and too much time is being lost due to interruptions, or
  - Scope creep
- > 20% higher than estimated effort
  - Any return on investment promised to management at the time of project approval is breached
  - Overtime by the project team is present; excessive overtime, in turn leads to eventual low productivity and low quality of the end product as well team burnout

Actual Resources vs. Planned Resources

There are 2 measurements of resources:
- The gap between the number of full time equivalent (FTE) team members actually working on the project vs. The number of FTE team members initially planned
- The amount of unplanned turnover – the number of FTE team members that have left the team unexpectedly

The gap of less than 10% - If short term, usually does not result in any appreciable hit on schedule, functionality, or quality of the end product
If the project is under resourced by 10 to 15% - serious hit on the quality of the end product, as there will be a little less testing, a little less documentation, and little less prototyping as planned
A resource gap > 15% - in addition to a hit on the quality of the product, there will be a hit on the scope of the project: client does not get what was promised
A resource gap > 20% - SOS – the schedule, scope, and quality of the project are all in jeopardy

**Unplanned staff turnover**

Based on 41 medium to large projects
- Unplanned turnover of a core team member causes the critical path to slip behind schedule by 4 to 6 weeks
- Unplanned turnover of a project manager delays a project by 6 to 9 weeks
- The change of a sponsor jeopardizes the entire project, as a new sponsor often wants to re-approve the projects budget, schedule, and mission

**Project health report card**

**Table 2. Project Vital Signs**

<table>
<thead>
<tr>
<th>Vital Sign</th>
<th>Variance</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Status of the Critical Path</td>
<td>&lt;10%</td>
<td>0</td>
</tr>
<tr>
<td>(Delay)</td>
<td>10% to 20%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;20%</td>
<td>2</td>
</tr>
<tr>
<td>2. Milestone Hit Rate (Gap)</td>
<td>&lt;10%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10% to 20%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;20%</td>
<td>2</td>
</tr>
<tr>
<td>3. Deliverable Hit Rate (Gap)</td>
<td>&lt;10%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10% to 20%</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>&gt;20%</td>
<td>4</td>
</tr>
<tr>
<td>4. Issues</td>
<td>No Issues</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Issues &lt; Deliv.</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Issues &gt; Deliv.</td>
<td>2</td>
</tr>
<tr>
<td>5. Cost-to-Date vs. Estimated Cost-to-Date (Higher)</td>
<td>&lt;10%</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>10% to 20%</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>&gt;20%</td>
<td>2</td>
</tr>
<tr>
<td>6. Actual Resources vs. Planned</td>
<td>&lt;10%</td>
<td>0</td>
</tr>
<tr>
<td>Resources (Shortage)</td>
<td>10% to 15%</td>
<td>2</td>
</tr>
<tr>
<td>------------------------------</td>
<td>------------</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>&gt; 15%</td>
<td>4</td>
</tr>
<tr>
<td>7. High Probability, High Impact Risk Events</td>
<td>1-3 Risks</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4-5 Risks</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>6-7 Risks</td>
<td>4</td>
</tr>
<tr>
<td>Assessment: 1-5 Green; 6-10 Yellow; 11-20 Red</td>
<td>Total</td>
<td></td>
</tr>
</tbody>
</table>

**Summary**

One thing is plan, another thing is acting according to that plan
To ensure that project is under control, project manager must have overview of what is happening and knowledge about what should be happening
Project manager must track “signs” of projects health or powerlessness and have knowledge and wisdom to act respectively.

**Used Literature**

- ProjectHALT Methodology, [http://www.center4pm.com/ProjectHALTt.pdf](http://www.center4pm.com/ProjectHALTt.pdf)
- RUP, [http://sce.uhcl.edu/helm/rationalunifiedprocess/index.htm](http://sce.uhcl.edu/helm/rationalunifiedprocess/index.htm)